TECHNICAL MANUAL
OPERATION AND MAINTENANCE INSTRUCTIONS
WITH PARTS LIST

Automotive Power tester

TEST SET, LOW VOLTAGE CIRCUIT, AUTOMOTIVE TYPE, 12/24V DC
PART NO. 7541
MODEL LVTS
TYPE 12/24
NSN 4910-00-092-9136

UMC ELECTRONICS CO.
460 Sacket Point Road
North Haven, CT 06473

FSCM 22680

DAAA09-83-C-0405

JOB ORDER NO. KBD45

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TEST SET, LOW VOLTAGE CIRCUIT, AUTOMOTIVE TYPE, 12/24V DC PART NO. 7641 MODEL LVTS TYPE 12/24 NSN 4910-00-092-9138

1 FEBRUARY 1984

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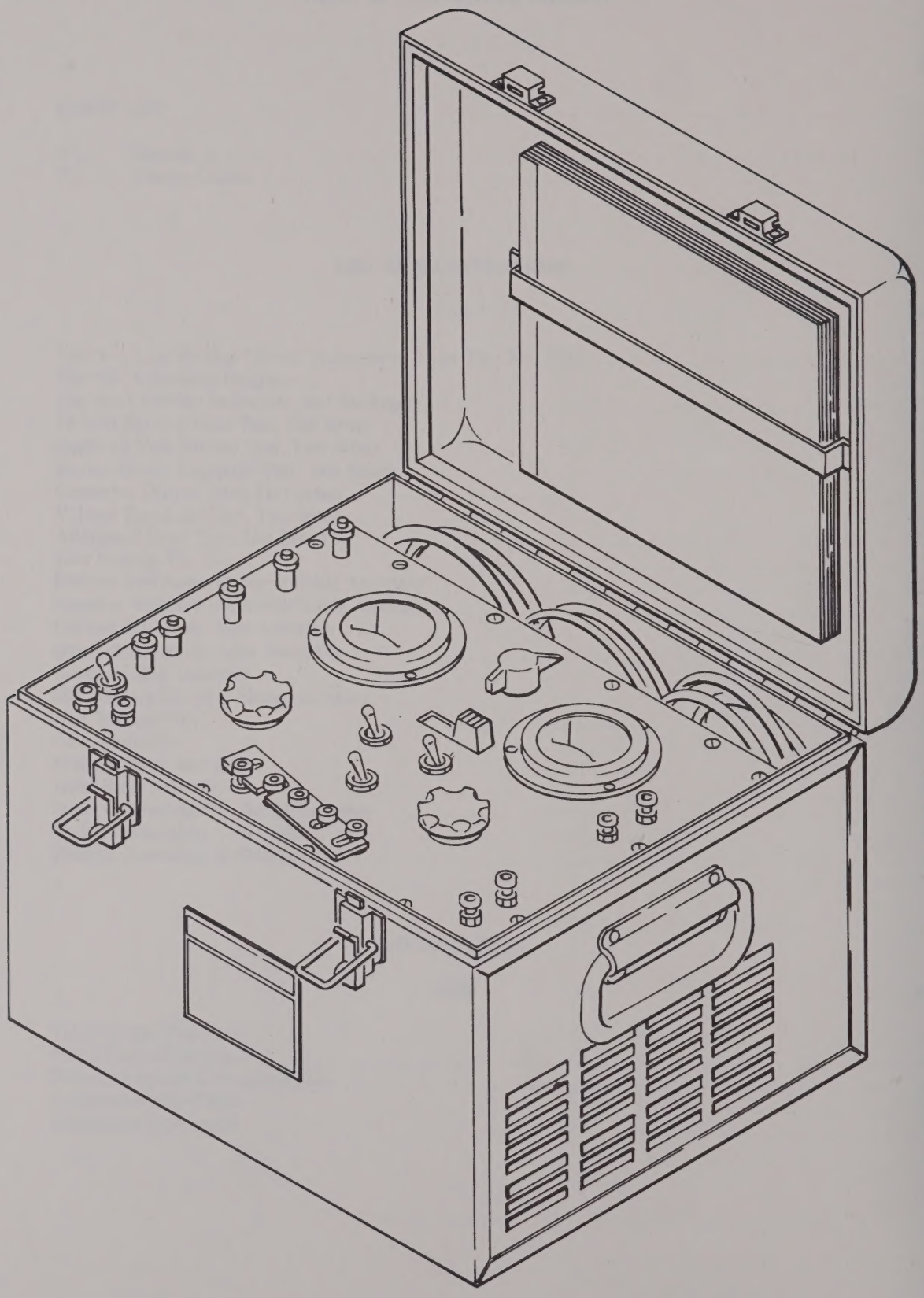


Figure 1-1. Test Set, Low Voltage Circuit, Automotive Type, Part No. 7541.

CHAPTER 1

INTRODUCTION

1-1. Scope. This technical manual provides operating and maintenance instructions and a parts list for Test Set, Low Voltage Circuit, Automotive Type, 12/24V DC, part number 7541, model LVTS (fig. 1-1). The test set is manufactured by UMC Electronics Co., 460 Sackett Point Road, North Haven, CT 06473.

1-2. Purpose of Equipment. The test set is used to test low voltage DC electrical circuits in automotive vehicles, tanks, and trucks. It contains a voltmeter circuit that can be used to measure the DC output voltages of the equipment undergoing test, an adjustable load bank and ammeter circuit that can be used to apply the required load to the equipment undergoing test, and a field rheostat that can be used for generator output control and regulator checks.

1-3. Description. The test set is a portable test set contained in a metal carrying case. Two carrying handles are provided at the sides of the case. A hinged top cover protects the instrument against damage when it is not in use. All operating controls, meters, and binding posts are located on a top panel which is accessible when the top cover is raised. The sides of the case are slotted to permit forced air ventilation of the internal load bank by an internal fan. A storage compartment at the rear of the case provides space for storing accessories supplied as part of the test set.

1-4. Equipment Supplied. In addition to the basic instrument, the following accessories are supplied:

a. Two 9-foot positive voltmeter/rheostat cable assemblies, color-coded and labeled, with an insulated spade lug at one end and an electrical clip and insulator at the other end.
b. Two 9-foot negative voltmeter/rheostat cable assemblies, color-coded and labeled, with an insulated spade lug at one end and an electrical clip and insulator at the other end.
c. One 9-foot positive ammeter cable assembly, color-coded and labeled, with a spade terminal at one end and an electrical clip and insulator at the other end.
d. One 9-foot negative ammeter cable assembly, color-coded and labeled, with a spade terminal at one end and an electrical clip and insulator at the other end.
e. One 1-foot jumper cable assembly with an electrical clip and insulator at each end.
f. One 500-ampere external ammeter shunt assembly, color-coded and labeled, with 1-foot leads terminated in an electrical clip and insulator for connection to the equipment undergoing test; two 9-foot, color-coded and labeled meter leads, terminated in spade terminals, are provided for connection to the test set.

NOTE

Two copies of the test set technical manual are also provided in brackets on the inside of the top cover.

1-5. Equipment Required But Not Supplied. Adapter Set, Engine, Electrical Test, NSN 4910-00-348-7600, is required for use with the test set, but is not supplied with the test set.

1-6. Leading Particulars. Leading particulars of the test set are listed in table 1-1.

Table 1-1. Table of Specification

CHARACTERISTIC	SPECIFICATIONS
Voltage Rating of Tested Systems	12 or 24 volts DC
Voltage Measurment Capability	0 to 50 volts DC
Current Measurement Capability	–3 to +500 amperes DC
Load Bank Range	0 to 100 amperes, continously adjustable, Duty Cycle 10 min. on, 10 min. off

Table 1-1. Table of Specifications (Continued)

CHARACTERISTIC	SPECIFICATIONS
Overall Dimensions	18 inches wide by 11 7/8 inches high by 14 3/4 inches deep
Total Weight	44 pounds

CHAPTER 2

PREPARATION FOR USE

2-1. UNPACKING AND INSPECTION.

a. Open the fiberboard shipping carton and remove the test set.
b. Remove the test set from the polyethylene bag.
c. Open the top cover of the test set and remove the cushioning material from the storage compartment at the rear of the test set case.
d. Remove all accessories from the storage compartment. Check to see that all accessories listed in paragraph 1-4 have been received.
e. Inspect the test set as follows for damage that may have occurred during shipment:

(1) Check the meters for cracked or broken windows.
(2) Check to see that the meter pointers are set to zero.
(3) Check to see that all switches operate smoothly without binding.
(4) Check to see that binding posts and knobs are undamaged.
(5) Check for loose or missing hardware.
(6) Check the case for dents or scratches.

2-2. Installation. The test set is a portable test set; therefore, no installation is required. Input voltages and currents are supplied from the equipment undergoing test. When the test set is to be used for equipment testing, set up the test set in a clear area convenient to the vehicle containing the equipment that is to be tested. Make sure that air flow through the test set slots is not restricted. Ensure that tools and other objects cannot fall across the test leads or onto the test set panel.

CHAPTER 3

THEORY OF OPERATION

3-1. General. The test set consists basically of an adjustable load bank, voltmeter and ammeter circuits, a field rheostat, and a cooling fan for the load bank. Figure 3-1 shows the circuit arrangement.

3-2. Voltmeter Circuit. The voltmeter circuit can be used to measure the output voltage of the equipment undergoing test, or as a general purpose voltmeter. Voltages to be measured are connected to the VOLTMETER J8 and J9 binding posts, using the voltmeter/rheostat cable assemblies. The VOLTMETER M1, is a voltmeter with four scales: 0 to 1 volt, 0 to 10 volts, 0 to 20 volts, and 0 to 50 volts. The VOLTS RNG S1 switch selects the meter range to be used. Resistors R3, R4, R5, and R6 are scaling resistors for the four meter ranges. Potentiometers R7, R8, R9, and R10 provide means for calibrating the four ranges. Initial accuracy is $\pm$ 2.0 percent of full scale. The meter movement is protected against momentary overload by an internal overload protection circuit.

3-3. LOAD BANK AND AMMETER CIRCUITS.

a. The load bank consists of four resistive legs. Three of the resistive legs provide means for adjusting the load applied to the equipment undergoing test in fixed steps of 50 amperes, 25 amperes, and 12.5 amperes. The fourth leg permits continuous adjustment of the load over the range of 0 to 12.5 amperes. The loads applied by the resistive legs are additive; by selecting the proper resistive legs, the load can be adjusted to any value between 5 and 100 amperes.

b. The equipment that is undergoing test is connected to the J5 binding post and one of binding posts J2, J3, and J4, depending on the maximum load current value, using the ammeter cable assemblies. An internal ammeter shunt connected to the binding posts provides proper scaling for the AMMETER, M2. The AMMETER, M2, is a ammeter with scales of –3 to +10 amperes, –15 to +50 amperes, –30 to +100 amperes, and –150 to +500 amperes. The scale to be read for any measurement is that scale that corresponds to the binding post that is being used. An internal overload protector circuit protects the ammeter movement against momentary overloads.

c. The load bank can accomodate either 12 volt or 24 volt DC systems. For 12 volt operation, a shorting link on the front panel is set to interconnect binding posts J12 through J16. With this arrangement, the upper load elements in figure 3-1 are shorted out, and only the lower load elements are effective. Switches S2, S3, S4, and S5 provide means for controlling load selection and application. Switch S5 is the master load switch; it connects and disconnects all selected loads simultaneously. Switch S2 controls a fixed 50 ampere load, switch S3 controls a fixed 25 ampere load, and switch S4 controls a fixed 12.5 ampere load. Potentiometer R1 provides a means for controlling a variable 0 to12.5 ampere load, and switch S4 controls a fixed 12.5 ampere load. Potentiometer R1 provides a means for controlling a variable 0 to 12.5 ampere load through transistor Q1. When potentiometer R1 is set fully counterclockwise, the transistor is turned off, and this resistive leg is effectively open. As the setting of potentiometer R1 is increased, the conduction of transistor Q1 increases, thereby increasing the load. When the potentiometer is set fully clockwise, transistor Q1 is on fully and the load current is limited to 12.5 amperes by the load bank element in the transistor emitter circuit. By operating switches S2 through S4 and potentiometer R1, any load value between 5 and 100 amperes can be selected. The total current drawn by the load bank is indicated on the AMPERES M2 meter.

d. For operation with 24 volt systems, the shorting link at binding posts J12 through J16 is opened, thereby removing the short across the upper load elements. The upper load elements are then connected in series with the lower load elements to maintain the same load currents at the higher input voltages.

e. The AMMETER, M2, can be used with the test set external shunt to measure the current drawn by starter motors during testing. For such operation, the EXT SHNT S6 switch is opened, thereby disconnecting the ammeter from the internal shunt. The external shunt is connected in series with the starter motor, and the meter leads on the external shunt are connected to the EXT SHNT J6 and J7 binding posts. Starter motor current is then indicated on the 500 ampere range of the AMMETER, M2.

3-4. Fan Circuit. Fan B1 draws cooling air through slots in the test set case to cool the load bank elements. The fan operates when the S5 master load bank switch is set to the ON position. When the test set is used with 12 volt systems, the fan is connected directly across the load bank through normally closed contacts of relay K1. When the test set is used with 24 volt systems, relay K1 is energized through resistor R13, and the relay contact opens. Dropping resistors R12 and R11 are then connected into the fan circuit to drop the applied 30 volts to 12 volts required for fan operation. Resistor R11 provides means for adjusting the fan voltage when operating from 30 volt systems.

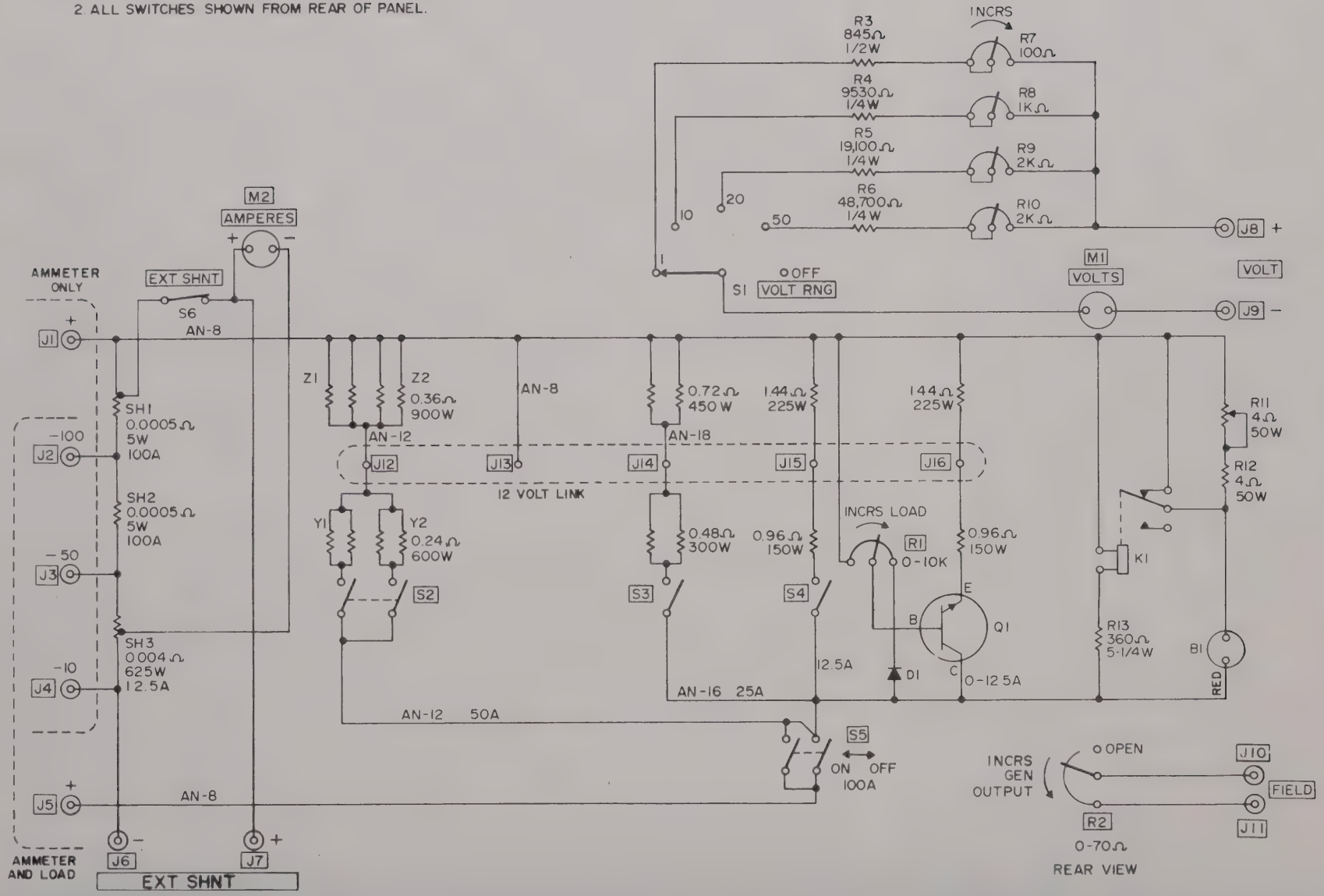


Figure 3-1. Test set, schematic diagram.

3-5. Field Rheostat. The R2 field rheostat is used to adjust the output voltage of generators undergoing test. Connections to the field rheostat are made through FIELD J10 and J11 binding posts with the voltmeter/rheostat cable assemblies. Clockwise rotation of the field rheostat reduces the resistance between the binding posts, thereby resulting in higher generator output voltage.

CHAPTER 4

OPERATING INSTRUCTIONS

4-1. General. Test requirements and test values for various items undergoing test will vary. Before using the test set to test any component or system, refer to the applicable technical manual or manufacturer's literature for that component or system to ascertain what tests are to be performed and what test values should be. Personnel performing tests should have a good understanding of the operating principles of the item being tested. The operating instructions in this chapter are typical; adapt these instructions in accordance with the test requirements and test values specified in the literature for the item that is to be tested.

NOTE

All tests are performed with the item being tested installed in the vehicle.

4-2. CONTROLS, INDICATORS, AND BINDING POSTS.

a. Ammeter Binding Posts and Ammeter. Ammeter binding posts (1, fig. 4-1) provide means for connecting equipment undergoing load testing to the test set. One positive binding post and three negative binding posts are provided. The negative binding posts are marked –10, –50, and –100, and these markings correspond to the full scale ranges of AMMETER, M2, (2). Load current is read on the meter range that corresponds to the selected negative binding post. The negative binding post to be used is selected according to the maximum load current. AMMETER, M2, (2), has a fourth range (500 amperes full scale) that is used with the test set external shunt.

NOTE

EXT SHNT S6 switch (15) must be set to the closed (down) position when AMMETER, M2, (2) is to be used to measure load currents.

b. Load Switches. S5 master load disconnect switch (4) controls application of selected loads to the equipment undergoing test. S4 12.5 ampere load switch (3), S3 25 ampere load switch (10), and S2 50 ampere load switch (11) allow the operator to select fixed load values as marked. The total selected load is the sum of the switch selected load plus the adjustable 0 to 12.5 ampere load provided by R1 0-12.5 ampere load control (13). All selected loads can be disconnected from the equipment undergoing test by setting S5 master load disconnect switch (4) to the OFF position. Applied loads are indicated on AMMETER, M2, (2).

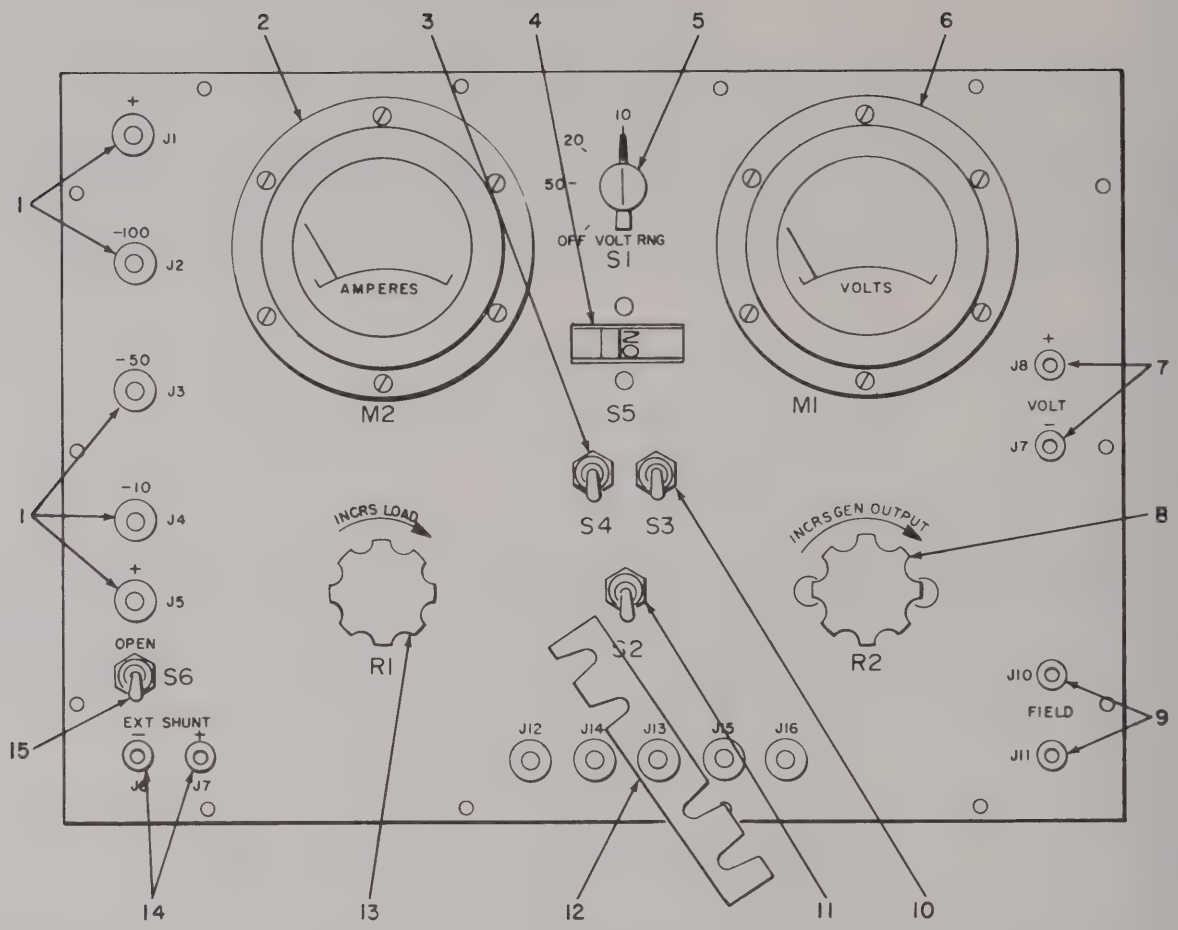
c. Voltmeter. VOLT input binding posts (7) provide means for connecting DC voltages to the test set for measurement. Measured values are shown on VOLTMETER, M1, (6), which has four active ranges. VOLT RNG S1 switch (5) allows the operator to select the appropriate meter range, or to turn off the voltmeter circuit.

d. Field Rheostat. R2 field rheostat (8) provides means for adjusting the output voltage of generators during testing. The field rheostat is connected to the generator through FIELD rheostat binding posts (9). Clockwise rotation of R2 field rheostat (8) results in an increase in the generator output voltage.

e. Shorting Link. Shorting link (12) provides means for converting the test set circuits for either 12 volt or 24 volt operation. For tests of 12 volt systems or components, the shorting link is closed to interconnect binding posts J12 through J16. For tests of 24 volt systems or components, the shorting link is opened.

f. R1 0-12.5 Ampere Load Control. R1 0-12.5 ampere load control (13) provides means for fine adjustment of the load over a range of 0 to 12.5 amperes. S5 master load disconnect switch (4) must be set to the ON position for this control to be operative.

g. External Shunt Switch and Binding Posts. The external shunt supplied with the test set is used to measure starter motor current draw during testing. For such tests, the meter leads of the external shunt are connected to EXT SHNT binding posts (14), and EXT SHNT S6 switch (15) is set to the OPEN position. AMMETER, M2, (2) is then connected to the external shunt instead of the internal shunt, and the starter motor current is indicated on the –150 to +500 ampere range of AMMETER, M2, (2). EXT SHNT S6 switch (15) must be returned to the closed (down) position for all other equipment tests.



1. Ammeter binding posts
2. AMMETER M2
3. S4 12.5 ampere load switch
4. S5 master load disconnect switch
5. VOLT RNG S1 switch
6. VOLTMETER M1
7. VOLT input binding post
8. R2 field rheostat
9. FIELD rheostat binding posts
10. S3 25 ampere load switch
11. S2 50 ampere load switch
12. Shorting link
13. R1 0 - 12.5 ampere load control
14. EXT SHNT binding posts
15. EXT SHNT S6 switch

Figure 4-1. Test set controls, indicators, and binding posts.

4-3. Initial Control Settings. Before making any connections between the test set and the equipment that is to undergo testing, set the test set controls to the positions listed in table 4-1.

4-4. GENERAL OPERATING NOTES.

CAUTION

Make sure that air flow through the slots in the test set case is not restricted.

a. Set up the test set in a clear area, either at the vehicle containing the equipment to be tested or on a test bench.
b. Make sure that tools and other foreign objects cannot fall across the test set cable assemblies or onto the test set panel.
c. Make sure that the test set controls are set to the initial positions listed in table 4-1 before making any connections.

Table 4-1. Initial Control Settings

CONTROL	FIG. 4-1 INDEX NO.	SETTING
S4 12.5 ampere load switch	3	OFF
S5 master load disconnect switch	4	OFF
VOLT RNG S1 switch	5	OFF
R2 field rheostat	8	Fully counterclockwise
S3 25 ampere load switch	10	OFF
S2 50 ampere load switch	11	OFF
Shorting link	12	Closed for 12 volt operation; open for 24 volt operation
R1 0-12.5 ampere load control	13	Fully counterclockwise
EXT SHNT S6 switch	15	OPEN for starter motor current tests; closed (down) for all other tests

CAUTION

Heavy currents are measured by the test set. Loose connections can result in damaging overheating and/or arcing.

d. When connecting cable assemblies, connect the spade terminal end of the cable assemblies to the test set binding posts, and connect the electrical clip end to the equipment undergoing test. Make sure all connections are tight.
e. Disconnect the clip ends of the cable assemblies from the equipment undergoing test before making any binding post connections or changes.

CAUTION

Damage may result if 24 volts is applied to the test set with the shortening link closed.

f. Make sure the shorting link is positioned properly for the system or equipment that is to be tested. Tighten the shorting link connections.

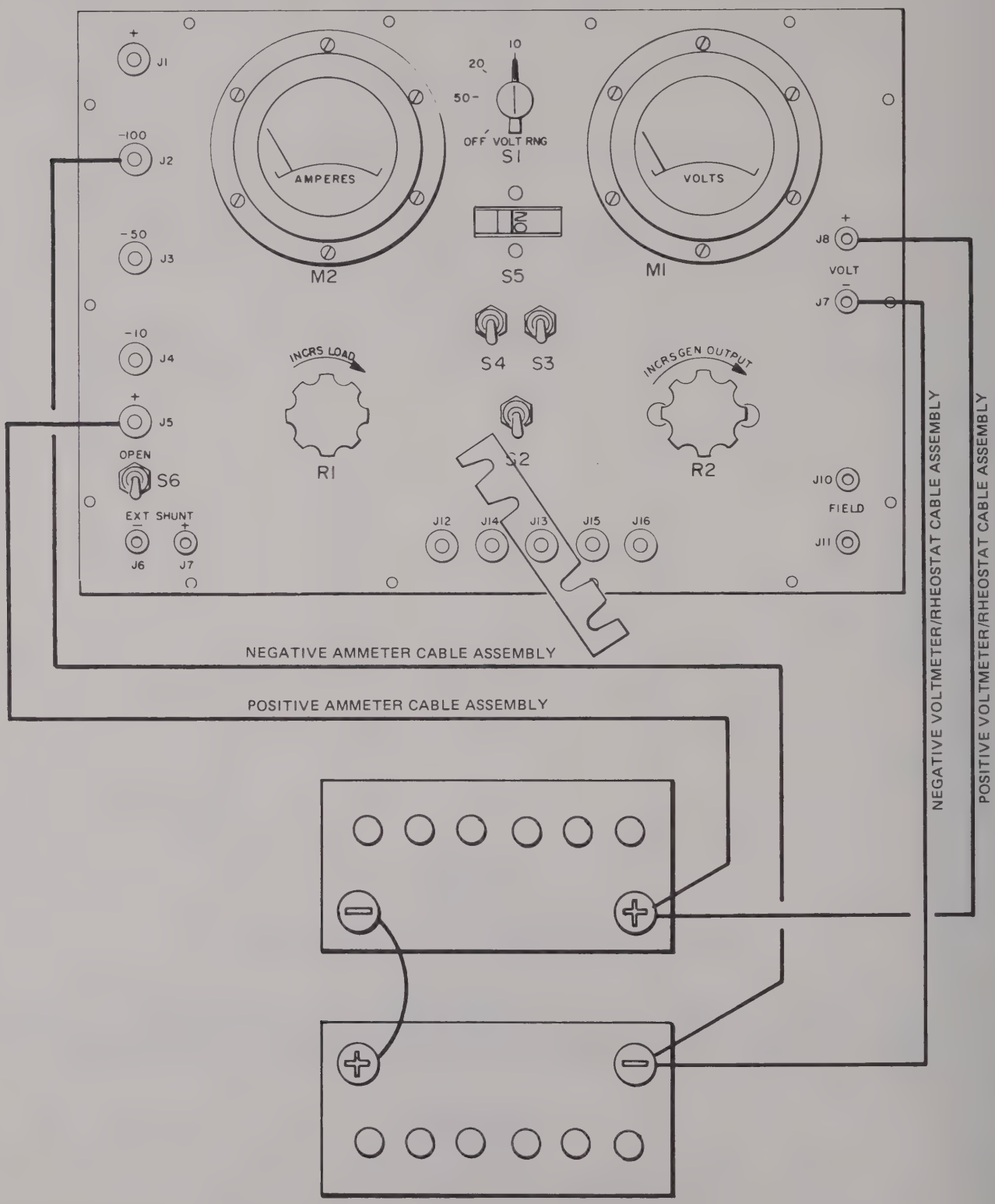


Figure 4-2. 24 volt battery load test, test setup.

4-5. 24 Volt Battery Load Test. This test checks the ability of a 24 volt battery to crank the engine. The test is performed by applying a specified load to the battery for 15 seconds, and checking the battery voltage under load. To perform this test, proceed as follows:

a. Set the test set controls to the initial positions listed in table 4-1. Secure shorting link (12, fig. 4-1) in the open position. Make sure EXT SHNT S6 switch (15) is set to the closed (down) position and shorting link is secured in open position.
b. Connect the test set to the battery as shown in figure 4-2.
c. Set VOLT RNG S1 switch (5) to the 50 position.
d. Set S5 master load disconnect switch (4) to the ON position.
e. Check the battery specifications to determine the required load current. Using S2 50 ampere load switch (11), S3 25 ampere load switch (10), and/or S4 12.5 ampere load switch (3), apply a load that is within 12.5 amperes of the specified load current. Read the applied load current on AMMETER, M2, (2).
f. Using R1 0-12.5 ampere load control (13), increase the load to the exact specified value.
g. Check the reading on VOLTMETER, M1, (6). The meter reading should be at least 18 volts with the load applied, and 24 to 26 volts with the load disconnected. If the voltage is not as specified, check each battery separately using the procedure in paragraph 4-6.
h. Return the test set controls to the positions listed in table 4-1. Disconnect the test set from the battery.

4-6. Single 12 Volt Battery Test. This test checks the 12 volt batteries individually. Proceed as follows:

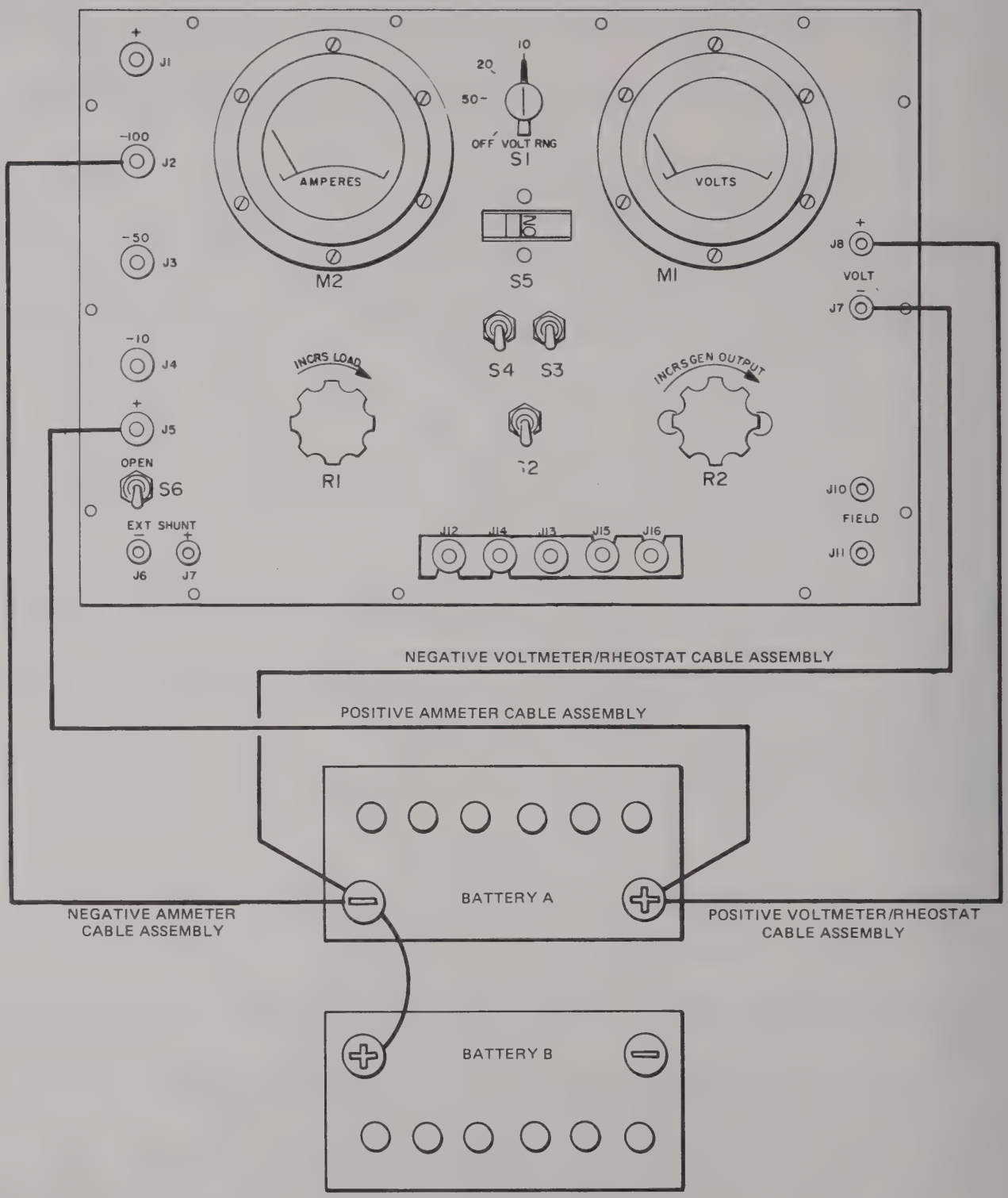
a. Set the test set controls to the initial positions listed in table 4-1. Secure shorting link (12, fig. 4-1) in the closed position. Make sure EXT SHNT S6 switch (15) is set to the closed (down) position.
b. Connect the test set to battery A as shown in figure 4-3.
c. Set VOLT RNG S1 switch (5) to the 20 position.
d. Set S5 master load disconnect switch (4) to the ON position.
e. Check the battery specifications to determine the required load test current. Using S2 50 ampere load switch (11), S3 25 ampere load switch (10), and/or S4 12.5 ampere load switch (3), apply a load that is 12.5 amperes or less lower than the specified test load. Read the applied load on AMMETER, M2, (2).
f. Using R1 0-12.5 ampere load control (13), increase the load to the exact specified value.
g. Check the reading on VOLTMETER, M1, (6). The meter reading should be at least 9 volts with the load applied, and 12 to 13 volts with the load disconnected.
h. Return the test set controls to the initial settings.
i. Move the voltmeter/rheostat and ammeter cable assembly connections from battery A to battery B. Observe polarity.
j. Repeat steps c through g above.
k. Return the test controls to the initial settings listed in table 4-1. Disconnect the test set from the battery.

NOTE

If either battery A or battery B is found to be defective, repair or replace the battery. Then, perform the 24 volt battery load test (paragraph 4-5).

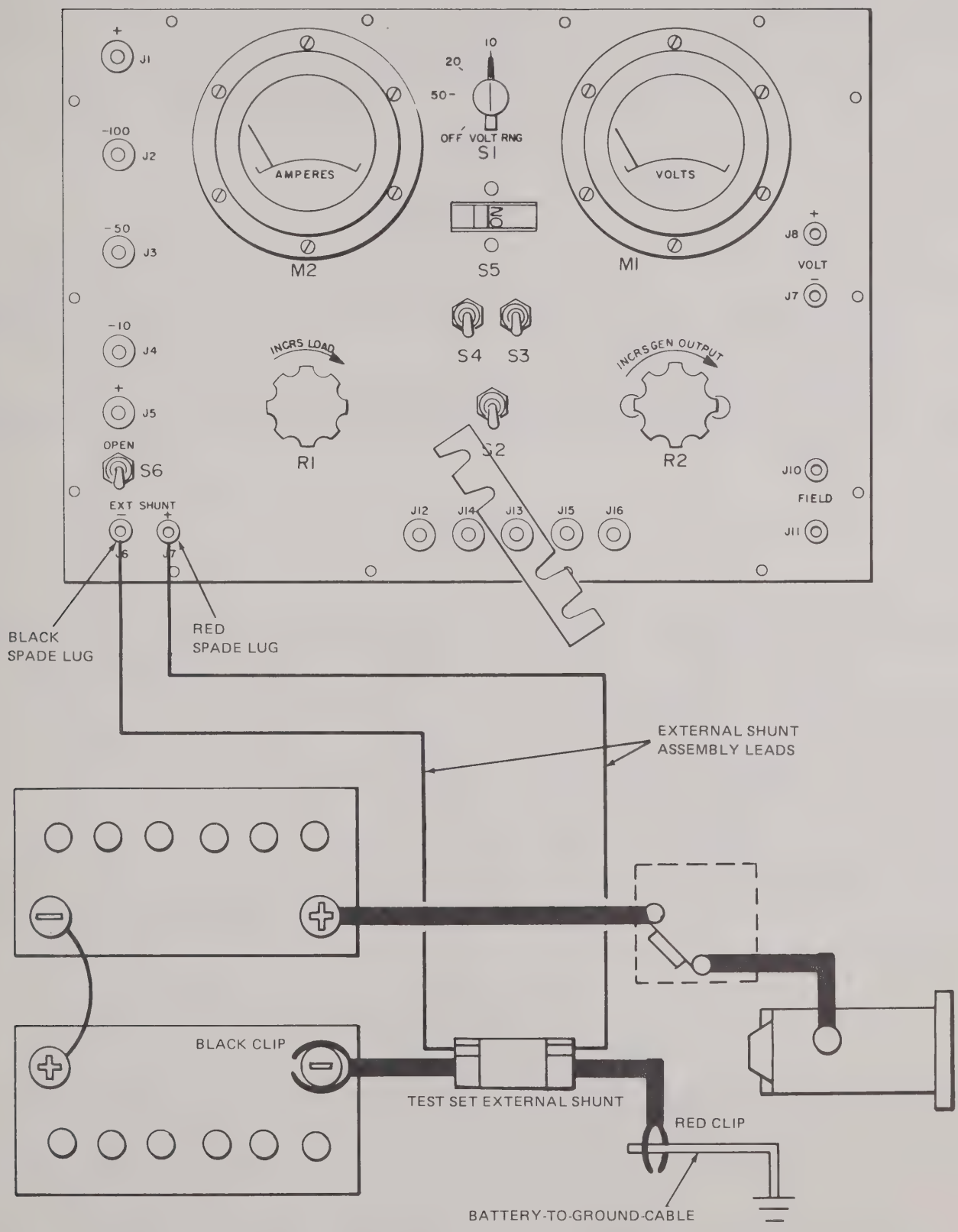
4-7. Starter Motor Amperage Test. This test is used to determine whether the current drawn by a starter motor is normal. It should be performed with the vehicle or equipment engine at normal operating temperature. To perform this test, proceed as follows:

a. Set the test set controls to the positions listed in table 4-1. Make sure EXT SHNT S6 switch (15) is set to the OPEN position and shorting link is secured in open position.
b. Disconnect the battery-to-ground cable from the battery negative terminal.
c. Connect the test set external shunt as shown in figure 4-4.
d. With the ignition switch in the OFF position and the gear shift lever in neutral or the clutch depressed, close the starter motor circuit, thereby cranking the engine.
e. Read the starter motor current on AMMETER, M2, (2, fig. 4-1). If the meter reading exceeds the stall-test current listed in the manufacturer's specifications, the starter motor is defective and must be repaired or replaced.
f. After the test has been completed, open the starter motor circuit. Disconnect the test set external shunt, and reconnect the battery-to-ground cable to the battery negative terminal.



NOTE:
OBSERVE BATTERY POLARITY WHEN SWITCHING CABLE ASSEMBLIES FROM BATTERY A TO BATTERY B.

Figure 4-3. Single 12 volt battery test, test setup.



(Typical 24 Volt)

Figure 4-4. Starter motor amperage test, test setup.

4-8. GENERATING SYSTEM TESTS.

WARNING

Contact with the exhaust pipe of the test vehicle may result in burns. Check the exhaust pipe before connecting or disconnecting adapters.

CAUTION

Observe load bank duty cycle.

a. Generator Output Test. This test checks the generator output capacity and checks the generator drive belt for slippage. During this test, the generator is operated at the speed (rpm) specified in the pertinent generator specifications. To perform this test, proceed as follows:

(1) Start and operate the vehicle engine until its temperature is normal.
(2) With the vehicle engine stopped, install regulator testing electrical test engine adapter, NSN 4910-00-092-9026, and generator testing electrical test engine adapter, NSN 4910-00-092-9025, in the generating system as shown in figure 4-5.

NOTE

The adapters are part of Adapter Set, Engine, Electrical Test, NSN 4910-00-348-7600.

(3) Polarize the generator by connecting the test set jumper cable assembly to terminal 1 of the regulator testing electrical test engine adapter, and briefly touching the other end of the jumper cable assembly to field terminal number 1 on the generator testing electrical test engine adapter. Remove the test set jumper cable.
(4) Set the test set controls to the positions listed in table 4-1. Make sure the shorting link is open, and the EXT SHNT S6 switch is in the closed (down) position.
(5) Set the two switch links on the generator testing electrical test engine adapter to the open position.
(6) Connect the test set to the generating system as shown in figure 4-5.
(7) Start the vehicle engine and operate it at high idle speed (1000 to 2000 rpm).
(8) Set VOLT RNG S1 switch (5, fig. 4-1) to the 50 position.
(9) Adjust R2 field rheostat (8) clockwise slowly until VOLTS M1 meter (6) indicates 30 volts.
(10) Set S5 master load disconnect switch (4) to the ON position.
(11) Set S3 25 ampere load switch (10) to the ON position.
(12) Readjust R2 field rheostat (8) to bring the reading on VOLTMETER, M1, (6) back to 30 volts. Check the reading on AMMETER, M2, (2). A current reading of at least 25 amperes at 30 volts should be obtained.

NOTE

Refer to the pertinent specifications for the particular generator undergoing test for other generator data.

(13) If a reading of 25 amperes cannot be obtained at 30 volts, check for a loose generator drive belt. If the drive belt is not slipping, replace the generator.
(14) After the test has been completed, shut off the vehicle engine. Set the test controls to the positions listed in table 4-1. Remove all test set cable assemblies and the test adapters. Close the links on the generator testing electrical test engine adapter to prevent damage.

b. Voltage Regulator Test. This test checks the voltage setting of the generator-regulator. The correct voltage setting, which is specified in the pertinent technical literature, is essential in maintaining a constant generator voltage value. In order to maintain a constant voltage, the generator supplies varrying current to meet the varying battery charge

state and electrical load conditions. Perform this test as follows:

(1) Start and operate the vehicle engine until its temperature is normal.
(2) Stop the vehicle engine. Install regulator testing electrical test engine adapter, NSN 4910-00-092-9025, in the generating system as shown in figure 4-6. Open the switch link on the adapter.

NOTE

The engine adapter is part of Adapter Set, Engine, Electrical Test, NSN 4910-00-348-7600.

(3) Set the test set controls to the positions listed in table 4-1. Make sure that the shorting link is open.
(4) Connect the test set to the generating system as shown in figure 4-6.
(5) Start the vehicle engine and set the throttle at a fast idle (approximately 1000 rpm) to attain a generator speed of approximately 1800 rpm.
(6) Set VOLT RNG S1 switch (5, fig. 4-1) to the 50 position.
(7) Check the reading on VOLTMETER, M1 (6). This reading indicates the setting of the voltage regulator unit; it should be as specified in the pertinent technical literature for the generator-regulator being tested.
(8) After the test has been completed, shut off the vehicle engine. Set the test controls to the positions listed in table 4-1. Disconnect the test set cable assemblies and the engine adapter. Close the switch link on the engine adapter to prevent damage.

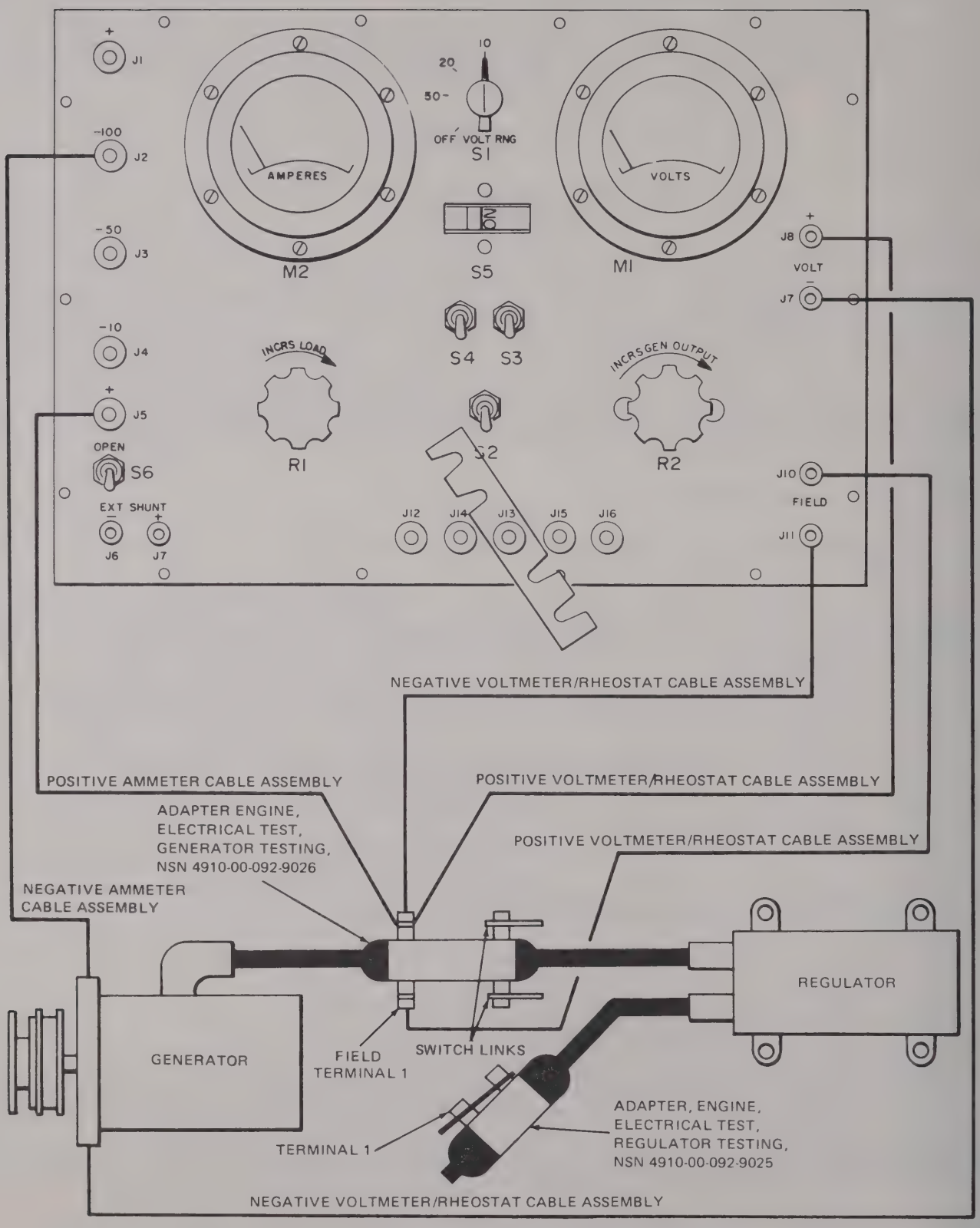
4-9. ALTERNATOR SYSTEM TEST.

a. Precautions. When working with alternators, observe the following precautions to prevent damage to the alternator or regulator:

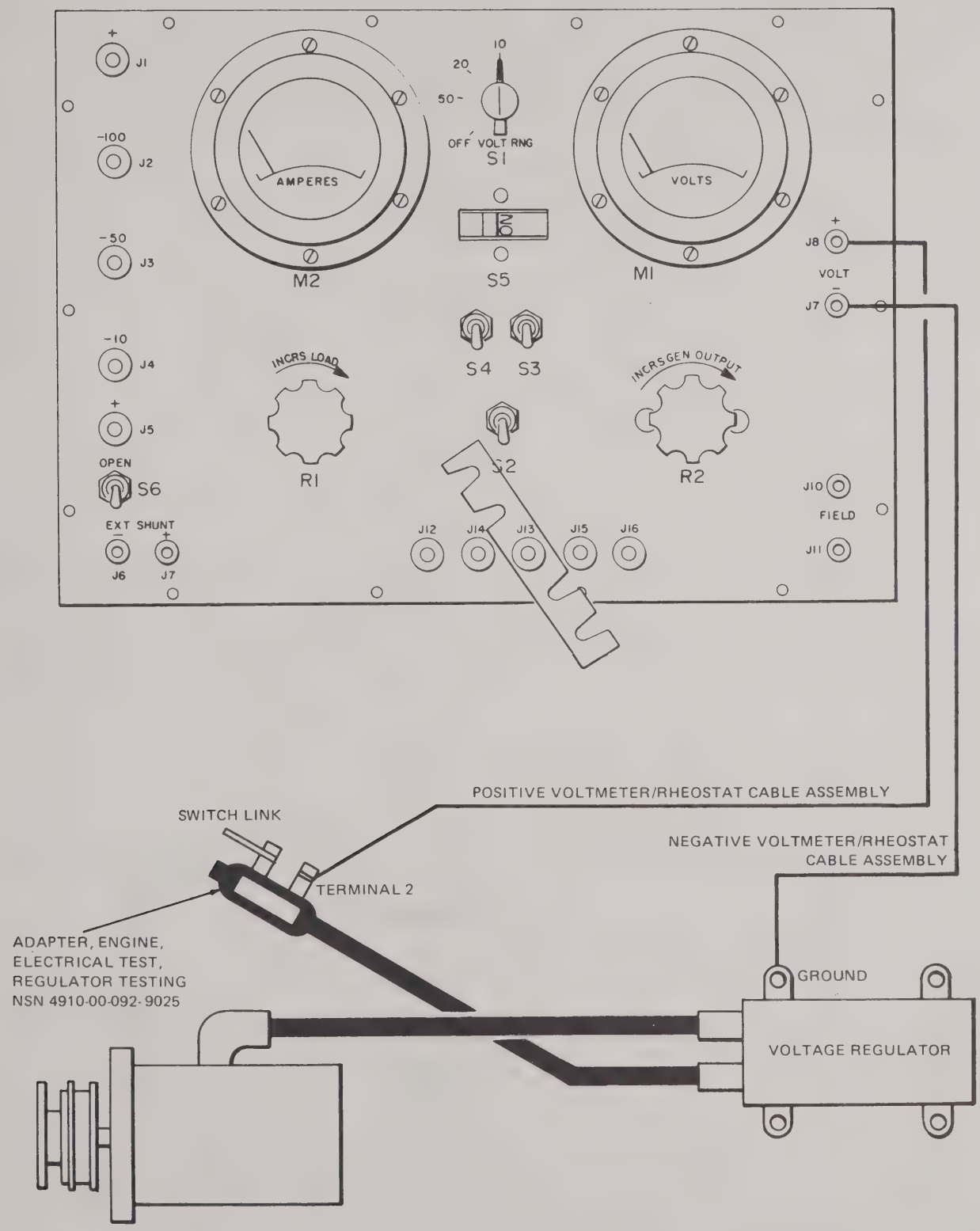
(1) Never reverse battery connections to the alternator. Always check the battery connecting cables with a voltmeter to determine polarity before making any connections to an alternator. Make sure that the negative battery cable is connected to the alternator frame, and the positive battery cable is connected to the alternator positive terminal.
(2) Never disconnect the voltage regulator sensing lead (ignition lead) while the vehicle engine is running. This lead supplies battery voltage information to the regulator. If it is removed, the regulator will burn out trying to reach 28 volts.
(3) Never ground the alternator output terminal. The internal resistance of an alternator is very low; therefore, an external short circuit will overload all regulating and generating circuits, resulting in burnout.
(4) Never operate the alternator with the ignition sensing (voltage sensing) terminal energized unless a load is connected to the alternator output.
(5) Never try to polarize an alternator. It is unnecessary, and could result in damage.

b. Alternator Load Test. This test checks the alternator output capacity. Refer to the pertinent alternator technical literature for test data and specifications. Perform this test as follows:

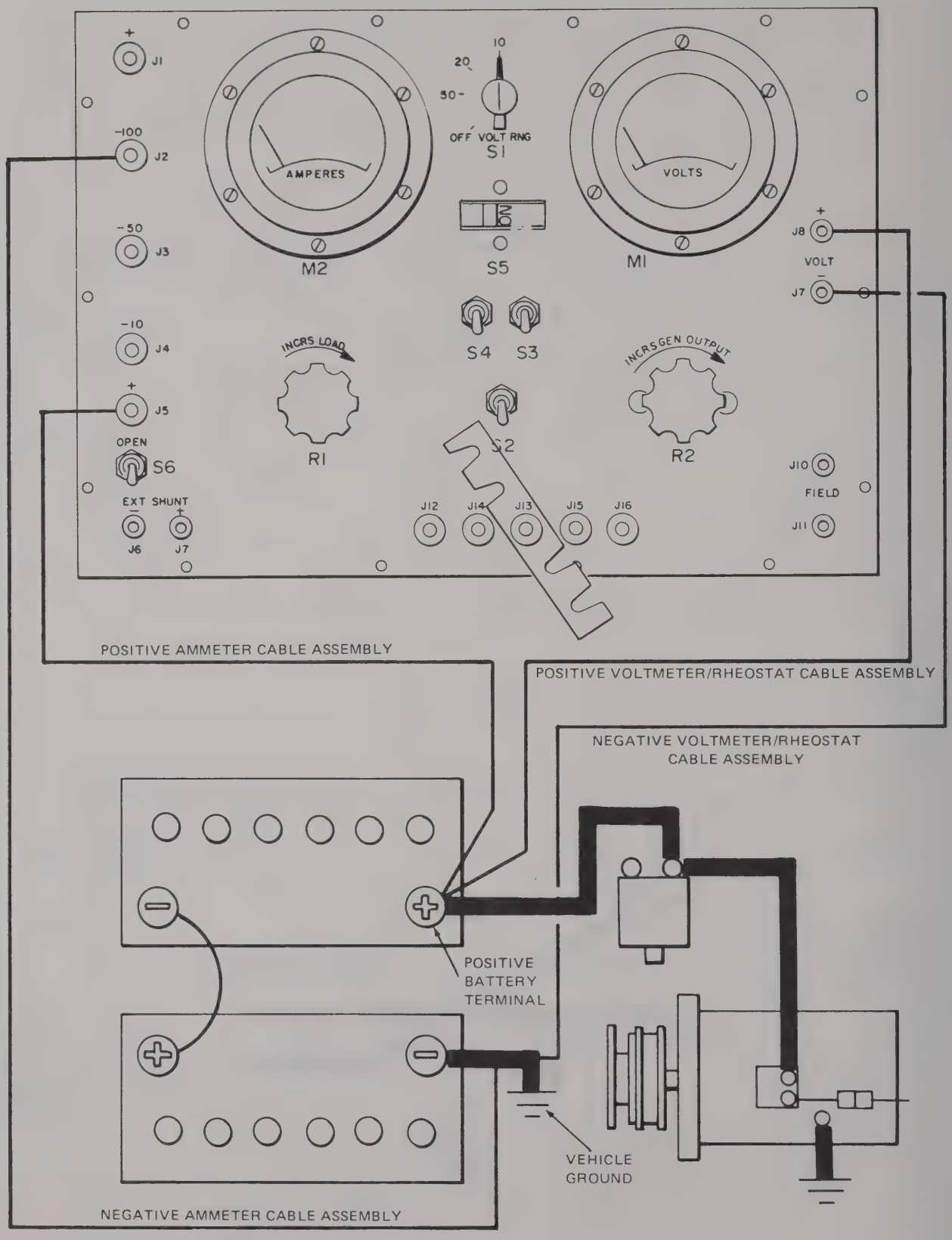
(1) Set the test set controls to the positions listed in table 4-1. Make sure that the shorting link is open, and the EXT SHNT S6 switch is set to the closed position.
(2) Connect the test set to the alternator system as shown in figure 4-7.
(3) Start the vehicle engine and run it at 1000 to 2000 rpm.
(4) Set VOLT RNG S1 switch (5, fig. 4-1) to the 50 position.
(5) Set S5 master load disconnect switch (4) and S2 50 ampere load switch (11) to the ON position.
(6) Adjust R1 0-12.5 ampere load control (13) until a reading of 60 amperes is obtained on AMMETER, M2, (2).
(7) Check the reading on VOLTS M1 meter (6). If this reading is 27 volts or higher, the alternator is operating satisfactorily.
(8) After the test has been completed, shut off the vehicle engine. Set the test set controls to the positions listed in table 4-1. Remove the test set cable assemblies.



(Typical 24 Volt)
Figure 4-5. Generator output test, test setup.



(Typical 24 Volt)
Figure 4-6. Voltage regulator test, test setup.



(Typical 60 Amp, 24 Volt)
Figure 4-7. Alternator load test, test setup.

CHAPTER 5

MAINTENANCE INSTRUCTIONS

5-1. CLEANING.

WARNING

Provide adequate ventilation both during and after use of trichloroethane. Avoid prolonged inhalation of vapors. Wear rubber gloves.

The use of diesel fuel oil, gasoline, or benzine (benzol) for cleaning is prohibited.

CAUTION

Avoid getting petroleum products on rubber parts, since these products can cause deterioration of rubber.

a. Painted Surfaces. Use clean water or a solution of either 1/4 pound of soap chips or 6 ounces of painted-surface detergent to 1 gallon of hot water for cleaning painted surfaces. After cleaning, dry the surfaces thoroughly.
b. Electrical Parts. Use technical trichloroethane (methyl chloroform), Specification O-T-620, to clean electrical parts. Do not immerse or soak painted parts or plastics in trichloroethane. Do not use thrichloroethane to clean rubber parts other than neoprene.
c. Rubber Parts. Clean rubber parts with soap and warm water. Apply a coating of powdered technical talcum, Specification ZZ-T-416, to preserve rubber.
d. Meters. Clean the glass of each meter using a soft cloth dampened with a solution of common detergent and water. After cleaning, allow the glass to dry without rubbing. Then, apply antistatic compound, Specification MIL-C-12156.

5-2. Lubrication. No lubrication is required.

5-3. Periodic Inspection. Periodic inspection requirements are listed in table 5-1. Periodic inspection will help keep the test set operating by revealing minor problems that can be corrected before they develop into major malfunctions. Perform the inspections listed in table 5-1 at the specified intervals.

5-4. Troubleshooting. If a malfunction occurs during use of the test set, proceed as follows:

a. Check the test connections and switch settings to make sure that the malfunction is not caused by an incorrect test set setup.
b. Shut down the test set and disconnect it from the equipment undergoing test. Remove the test set from its case, and perform a thorough visual inspection. Check for loose electrical connections, damaged leadwires and components, and signs of overheating.

WARNING

To protect personnel, install a wire guard over the fan blade if the test set is to be operated outside its case.

c. If the cause of the malfunction is not found through visual inspection, use the troubleshooting procedures in table 5-2 to isolate the defective part. Use the schematic diagram (fig. 3-1) to supplement the troubleshooting procedures.

Table 5-1. Periodic Inspection Requirements

INTERVAL	ITEM	PROCEDURE
Before each use	Meters	Check for cracked or broken glass, bent, broken, or sticking pointers, and incorrect zeroing.
	Switches	Check for binding and physical damage.
	Control knobs	Check for chips and cracks. Check for loose or missing setscrews.
	Test leads	Check for damage insulation, wiring breaks, and damaged clips.
	Air vents	Check air vents in the case for obstructions.
	Binding posts	Check for loose mounting and physical damage.
	Hardware	Check for loose or missing mounting hardware.
	Case	Check for rust, corrosion, and chipped or loose paint.
During use	Fan	Make sure the fan operates and draws cooling air through the air vents in the case.
Monthly	Internal wiring	Check for loose connections and damaged insulation.
	Internal components	Check for loose connections, loose mounting hardware, and signs of overheating.

Table 5-2. Troubleshooting Chart

TROUBLE	PROBABLE CAUSE	REMEDY
AMMETER M2 is inoperative.	Incorrect cable assembly connections	Recheck all connections between test set and equipment undergoing test. Correct any faults.
	EXT SHNT S6 switch incorrectly set	Set switch to position specified for test being conducted.
	Loose wiring connection	Check wiring between binding posts and meter. Tighten loose connections.
	Defective AMMETER M2	Replace defective meter.
Erroneous readings obtained on AMMETER M2.	Incorrect cable assembly connections	Make sure external cable assemblies are connected to correct binding posts.
	Loose electrical connection	Check electrical connections to internal shunt assembly. Tighten loose connections.
	Damaged internal shunt assembly	Replace defective shunt assembly.
	Defective AMMETER M2	Replace defective meter.

Table 5-2. Troubleshooting Chart (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
VOLTMETER M1 is completely inoperative.	VOLT RNG S1 switch set to OFF position. Open connection to binding posts	Set switch to appropriate range setting. Check cable assembly connections to VOLT binding posts. Tighten loose connections.
	Defective VOLTMETER M1	Replace defective meter.
	Defective VOLT RNG S1 switch	Replace defective switch.
VOLTMETER M1 is inoperative on only one range.	Defective scaling resistor or calibrating potentiometer	Check scaling resistor and calibrating potentiometer (R3 through R10) for affected range. Replace defective part.
	Defective VOLT RNG S1 switch	Replace defective switch.
No load current can be obtained during load tests.	S5 master load disconnect switch incorrectly set or defective	Set switch to ON position. Replace switch if it is defective.
Load currents are all low during 12 volt operation.	Shorting strap is open	Make sure shorting strap is closed and connections are tight.
Load does not increase by 50 amperes when S2 50 ampere load switch is closed	Loose electrical connection to load bank assembly	Tighten electrical connections at load bank assembly terminals.
	Defective S2 50 ampere load switch	Replace defective switch.
	Defective load bank element	Check 50 ampere load bank elements. Replace defective element.
Load does not increase by 25 amperes when S3 25 ampere load switch is closed.	Loose electrical connection to load bank assembly	Tighten electrical connections at load bank assembly terminals.
	Defective S3 25 ampere load switch	Replace defective switch.
	Defective load bank element	Check 25 ampere load bank elements. Replace defective element.
Load does not increase by 12.5 amperes when S4 12.5 ampere load switch is closed.	Loose electrical connection to load bank assembly	Tighten electrical connections at load bank assembly terminals.
	Defective S4 12.5 ampere load switch	Replace defective switch.
	Defective load bank element	Check 12.5 ampere load bank elements. Replace defective element.
R1 0-12.5 ampere load control has no effect or incorrect effect on load current.	Defective transistor Q1	Replace defective transistor Q1.
	Defective R1 potentiometer	Replace defective potentiometer.
	Defective load bank element	Check load bank element associated with transistor Q1. Replace defective element.
Load bank fan is inoperative.	Defective motor B1	Replace defective fan motor.

Table 5-2. Troubleshooting Chart (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
Load bank fan operates at high speed during 24 volt operation	Defective relay circuit	Check relay K1 and resistor R13. Replace defective part.
AMMETER M2 reads incorrectly when using external shunt assembly.	EXT SHNT S6 switch incorrectly set or shorted	Set switch to OPEN position. Replace switch if it is defective.
AMMETER M2 is inoperative using external shunt assembly.	Loose electrical connection	Check electrical connections between meter and EXT SHNT binding posts. Tighten loose connections.
	Defective external shunt assembly or connections to test set	Check external shunt connections; tighten, if loose. Check external shunt assembly with ohmeter. Repair any defects.

When the cause of the malfunction has been located, remove and replace the defective part. Then test the test set, using the procedures of paragraph 5-8, to ensure that all problems have been corrected.

CAUTION

Do not connect an ohmmeter across the test set meter terminals while troubleshooting. The ohmeter output voltage may damage the meter movement.

5-5. DISASSEMBLY.

a. General. Complete disassembly of the test set is not required. Disassemble the test set only to the extent required to facilitate removal and replacement of a defective part. Use the following procedures as applicable.

NOTE

Disconnect any electrical connections before removing any part from the test set. Tag the connecting leadwires to ensure that they will be reconnected properly during assembly.

b. Test Set (fig. 7-1)

(1) Unlatch the cover clamps and open the hinged top cover of case assembly (11).
(2) Remove cable assemblies (1 through 5) and external shunt assembly (6) from the storage compartment at the rear of case assembly (11).
(3) Do not remove nameplate (7) from case assembly (11) unless it is mutilated or illegible and requires replacement.
(4) Remove screws (9) and lift unit subassembly (8) out of case assembly (11). Set unit subassembly (8) down carefully, protecting the fan blade against damage.
(5) Do not remove schematic (10) from case assembly (11) unless it is illegible or mutilated.

c. Voltmeter/Rheostat Cable Assemblies (fig. 7-2 and 7-3)

(1) Do not remove spade lug (1) from wire (5) unless it is damaged and requires replacement.
(2) Slide insulator (3) back off clip (2), and disconnect clip (2) from wire (5). Remove clip (2) and insulator (3).
(3) Do not remove markers (4) from wire (5) unless replacement is required.

d. Positive Ammeter Cable Assembly (fig. 7-4)

(1) Cut away tubing (1 and 2).
(2) If replacement is required, remove lug (3) from wire (8).
(3) Slide insulator (5) back off clip (4). Disconnect clip (4) from wire (8). Remove clip (4) and insulator (5).
(4) If replacement is required, remove terminals (6) from wire (8).
(5) Do not remove markers (7) from wire (8) unless replacement is required.

e. Negative Ammeter Cable Assembly (fig. 7-5)

(1) Cut away tubing (1).
(2) If replacement is required, remove lug (2) from wire (7).
(3) Slide insulator (4) back off clip (3). Disconnect clip (3) from wire (7). Remove clip (3) and insulator (4).
(4) If replacement is required, remove terminals (5) from wire (7).
(5) Do not remove markers (6) from wire (7) unless replacement is required.

f. Jumper Cable Assembly (fig. 7-6)

(1) Slide insulators (2) back off clips (1). Remove clips (1) and insulators (2) from wire (4).
(2) Do not remove markers (3) from wire (4) unless replacement is required.

g. External Shunt Assembly (fig. 7-7)

(1) If replacement is required, remove space lugs (1 and 2) from wires (11).
(2) Slide insulators (4 and 6) back off clips (3 and 5), and remove clips (3 and 5) and insulators (4 and 6) from cables (15).
(3) Cut away tubing (7).
(4) Disconnect terminals (8) from shunt (16). Remove terminals (8) from wires (11) if replacement is required. Do not remove markers (9 and 10) unless they are mutilated or illegible and require replacement.
(5) Disconnect terminals (12) from shunt (16). If replacement is required, remove terminals (12) from cables (15). Do not remove markers (13 and 14) from cables (15) unless they are mutilated or illegible and require replacement.

h. Unit Subassembly (fig. 7-8)

(1) Disconnect all electrical connections between control panel assembly (1) and load bank assembly (4). Tag disconnected items to facilitate assembly.
(2) Remove screws (2) and washers (3), and separate control panel assembly (1) from load bank assembly (4).

i. Case Assembly (fig. 7-9)

(1) Remove bumpers (1) from case (6).
(2) If clasps (2) require replacement, drill out rivets (3) and remove clasps (2) from case (6).
(3) If handles (4) require replacement, drill out rivets (5) and remove handles (4) from case (6).

j. Control Panel Assembly (fig. 7-10)

(1) Tag and disconnect the leadwires from the terminals of ammeter (1). Remove the ammeter mounting hardware, and remove the ammeter from panel (34).
(2) Tag and disconnect the leadwires from the terminals of voltmeter (2). Remove the voltmeter mounting hardware, and remove the voltmeter from panel (34).
(3) Tag and disconnect the leadwires from the terminals of switch (3). Loosen the setscrew in the switch knob, and remove the knob. Remove the switch mounting hardware, and remove switch (3) from panel (34).
(4) Loosen the setscrew in knob (4) and remove the knob from potentiometer (5).
(5) Tag and disconnect the leadwires from the terminals of potentiometer (5). Remove the potentiometer mounting hardware, and remove potentiometer (5) from panel (34).
(6) Loosen the setscrew in knob (6) and remove the knob from rheostat (7). Tag and disconnect the leadwires from the terminals of the rheostat. Remove screws (8) and washers (9), and remove rheostat (7) from panel (34).
(7) Disconnect bus bars (10) from the terminals of switch (11). Remove screws (12), and remove switch (11) from panel (34).

(8) Tag and disconnect the leadwires from the terminals of switches (13, 14, and 15). Remove the switch mounting nuts and lockwashers, and remove the switches from panel (34).
(9) Loosen thumb nuts (32) on binding posts J12, J14, J15, and J16. Remove thumb nut (32) from binding post J13, and remove link (16).
(10) Remove the nuts and washers at the bottom of binding posts (17 and 18). Tag and disconnect the leadwires from the binding posts. Separate the two sections of each binding post, and remove the binding posts from panel (34).
(11) Remove nuts (20) and lockwashers (21) at the bottom of binding posts J1 through J5. Remove internal shunt assembly (19). Tag and disconnect the lead from binding post J5.
(12) Remove shoulder washers (22) from studs (26). Remove studs (26) with assembled parts from panel (34). Remove flat washers (24), lockwashers (21), nuts (20), and thumb nuts (25) from studs (26).
(13) Remove nuts (27) and lockwashers (28), and disconnect lugs from studs (33).
(14) Remove flat washers (29 and 30) from studs (33). Remove studs (33) with assembled parts from panel (34). Remove shoulder washers (31), flat washers (29), lockwashers (28), nuts (27), and thumb nuts (32) from studs (33).

k. Load Bank Assembly (fig. 7-11)

(1) Remove spacers (1) from enclosure (39) by removing screws (2) and lockwashers (3).
(2) Loosen the setscrews in blade (4), and remove the blade from motor (9).
(3) Tag and disconnect the leadwires from motor (9). Remove bracket (5) with attached motor (9) from enclosure (39) by removing screws (6), washers (7), lockwashers (3), and nuts (8).
(4) Remove motor (9) from bracket (5) by removing nuts (8) and lockwashers (3).
(5) Tag and disconnect the leadwires from the terminals of relay (10). Remove the relay mounting nut and lockwasher, and remove the relay from enclosure (39).
(6) Disconnect resistor (11) from terminal block (12). Tag and disconnect the leadwires from terminal block (12). Remove the terminal block from enclosure (39) by removing screws (13), washers (14), lockwashers (15), and nuts (16).
(7) Tag and disconnect the leadwires from the terminals of resistors (17 and 18). Remove screws (19), washers (20), lockwashers (21), and nuts (22), and remove the resistors with their mounting brackets from enclosure (39).
(8) Tag and disconnect the leadwires from the terminals of p.c. board assembly (23). Remove the p.c. board assembly from enclosure (39) by removing screws (24), washers (20), spacers (25), lockwashers (21), and nuts (22).
(9) Tag and disconnect the leadwires from the terminals of transistor (26). Remove transistor (26) from heat sink (27) by removing screws (24), washers (20), lockwashers (21), and nuts (22).
(10) Remove heat sink (27) from enclosure (39) by removing nuts (22), lockwashers (21), washers (20), insulators (28), and screws (19).
(11) Remove nuts (31) and lockwashers (32) from screws (36), and remove bus bars (29 and 30).
(12) Remove remaining nuts (31), lockwashers (32), washers (33), and shoulder washers (34) from screws (36). Withdraw screws (36) with attached parts into enclosure (39). Remove washers (35 and 33) and load elements (37 and 38) from screws (36).

l. P.C. Board Assembly (fig. 7-12)

CAUTION

Avoid excessive heating when removing parts from the printed circuit board. Use a low-wattage soldering iron and apply just enough heat to unsolder the connections.

(1) Disconnect resistors (1 through 4) and remove the resistors from printed circuit board (9).
(2) Disconnect potentiometers (5 through 7), and remove the potenetiometers from printed circuit board (9).
(3) Do not remove terminals (8) from printed circuit board (9) unless they are damaged and require replacement.

5-6. Repair or Replacement. Replace all detail parts that are found to be defective. Do not attempt to repair defective detail parts.

5-7. Assembly. Assembly is the reverse of disassembly. Note the following special instructions:

a. Make all electrical connections as tagged during disassembly. Also see figure 3-1.

b. Make sure all electrical connections are tight.
c. If soldering is necessary, make sure the connections to be soldered are mechanically secure. Solder the connections in accordance with MIL-STD-454, Requirement 5, using rosin based flux only.
d. When installing transistor (26, fig. 7-11), apply a generous coating of termal joint compound, series 120-13, manufactured by 05820, between the transistor and heat sink (27).
e. When installing binding posts and load bank element attaching screws, make sure that the fiber shoulder washers and fiber flat washers are installed correctly to insulate the binding post studs and load bank screws from the surface on which the parts are being installed.
f. Use the minimum heat possible when soldering connections at printed circuit board (9, fig. 7-12).
g. Shrink tubing and markers on cable assemblies and the external shunt assembly at 325°F using a suitable heat source.

5-8. Adjustment. If any component in the fan circuit was changed, adjust the test set fan circuit as follows:

a. Remove the unit subassembly from the case assembly.
b. Loosen the adjustment band on resistor R11.
c. Set the test set controls to the positions listed in table 4-1.
d. Connect an adjustable 0-30 volt DC power supply to the test set binding posts. Connect the positive output lead from the DC power supply to binding post J5, and connect the negative output lead to binding post J2.

WARNING

Install a wire guard over the fan blade.

e. Turn on the DC power supply and adjust its output voltage to 30 volts.
f. Connect a multimeter, with its controls set for DC voltage measurement, across the terminals of motor B1. Observe polarity.
g. Set the S5 master load disconnect switch on the test set to the ON position. Adjust the band on resistor R11 to the position that produces a 12 volt reading on the multimeter. Tighten the adjusting band hardware, being careful not to disturb the adjustment.
h. Set the S5 master load disconnect switch to the OFF position. Turn off the DC power supply and disconnect it from the test set. Remove the wire guard from the fan blade.
i. Install the unit assembly in the case assembly.

5-9. Testing. Perform the following tests after repair to ensure that all defects have been corrected:

a. Connect an ohmeter between FIELD binding posts J10 and J11. Set the R2 field rheostat fully clockwise; the ohmeter should read zero ohm. Rotate the R2 field rheostat counterclockwise; the resistance reading should increase smoothly to 70 ohms, and then rise to infinity.
b. Set the VOLT RNG S1 switch to the OFF position. Connect an adjustable 0 to 50 volt DC power supply to VOLT binding posts J8 and J9. Observe polarity. Then:

(1) Set the output voltage of the DC power supply to 50 volts. Set the VOLT RNG S1 switch to the 50 position. Verify that a reading of 50 volts is obtained on the VOLTMETER, M1.
(2) Set the output voltage of the DC power supply to 20 volts. Set the VOLT RNG S1 switch to the 20 position. Verify that a reading of 20 volts is obtained on the VOLTS M1 meter.
(3) Set the output voltage of the DC power supply to 10 volts. Set the VOLT RNG S1 switch to the 10 position. Verify that a reading of 10 volts is obtained on the VOLTS M1 meter.
(4) Set the output voltage of the DC power supply to 1 volt. Set the VOLT RNG S1 switch to the 1 position. Verify that a reading of 1 volt is obtained on the VOLTS M1 meter.
(5) Set the VOLT RNG S1 switch to the OFF position. Turn off the DC power supply and disconnect it from the test set.

c. Set the test set controls to the positions listed in table 4-1. Connect a fully charged 24-volt battery to the test set as shown in figure 4-2. Then:

(1) Set the S5 master load disconnect switch to the ON position. The test set fan should operate.
(2) Slowly turn the S1 0-12.5 ampere load control clockwise. The reading on the AMPERES M2 meter should be adjustable over a range of approximately 12.5 amperes with this control. Set the S1 0-12.5 ampere load control to its fully counterclockwise setting.

(3) Set the S4 12.5 ampere load switch to the ON position. The reading on the AMPERES M2 meter should increase by approximately 12.5 amperes. Set the switch to the OFF position.
(4) Set the S3 25 ampere load switch to the ON position. The reading on the AMPERES M2 meter should increase by approximately 25 amperes. Set the switch to the OFF position.
(5) Set the S2 50 ampere load switch to the ON position. The reading on the AMPERES M2 meter should increase by approximately 50 amperes.
(6) With the S2 50 ampere load switch still set to the ON position, set EXT SHNT switch S6 to the OPEN position. The reading on the AMPERES M2 meter should drop to zero.
(7) Set the S2 50 ampere load switch and the S5 master load disconnect switch to the OFF position. Disconnect the battery from the test set.

5-10. CALIBRATION.

a. Calibration Equipment. Equipment required for calibration is listed in table 5-3.
b. Calibration Procedure.

(1) Remove the unit subassembly from the case assembly.
(2) Set the VOLT RNG S1 switch to the OFF position.
(3) Connect the DC power supply to the VOLT J8 and J9 binding posts. Observe polarity.
(4) Connect the voltmeter standard between the VOLT J8 and J9 binding posts. Observe polarity.
(5) Turn on the DC power supply.
(6) Set the VOLT RNG S1 switch to the 50 position. Increase the output voltage of the DC power supply until a reading of exactly 50 volts is obtained on the voltmeter standard. Adjust potentiometer R10, if necessary, to obtain a reading of 50 volts on the VOLTS M1 meter.
(7) Reduce the output voltage of the DC power supply until the voltmeter standard reads exactly 20 volts. Set the VOLT RNG S1 switch to the 20 position. Adjust potentiometer R9, if necessary, to obtain a reading of 20 volts on the VOLTS M1 meter.
(8) Reduce the output voltage of the DC power supply until a reading of exactly 10 volts is obtained on the voltmeter standard. Set the VOLT RNG S1 switch to the 10 position. Adjust potentiometer R8, if necessary, to obtain a reading of 10 volts on the VOLT M1 meter.
(9) Reduce the output voltage of the DC power supply until a reading of exactly 1 volt is obtained on the voltmeter standard. Set the VOLT RNG S1 switch to the 1 position. Adjust potentiometer R7, if necessary, to obtain a reading of 1 volt on the VOLTS M1 meter.
(10) Set the VOLT RNG S1 switch to the OFF position. Turn off the DC power supply. Disconnect the DC power supply and the voltmeter standard from the test set.
(11) Install the unit subassembly in the case assembly.

Table 5-3. Calibration Equipment

NOMENCLATURE	PART/MODEL NO.	APPLICATION	RANGE	ACCURACY
Voltmeter standard		VOLTS M1 meter calibration	0-50V	±0.5%
DC power supply		VOLTS M1 meter calibration	0-50V	NA

CHAPTER 6

PREPARATION FOR STORAGE AND RESHIPMENT

6-1. PREPARATION FOR STORAGE.

a. Pack the test leads and the external shunt in the storage compartment at the rear of the test set case. Cushion these items with suitable cushioning material to prevent movement.
b. Place the technical manuals for the test set in the manual holding brackets on the inside of the cover.
c. Close and secure the top cover.
d. Place the test set in a polyethylene bag. Close the open end of the bag and tape it shut with suitable tape.

6-2. PREPARATION FOR SHIPMENT.

a. Repeat steps a through d of paragraph 6-1.
b. Pack the test set in a suitable fiberboard shipping carton. Seal the carton with tape.
c. Mark the carton to indicate the contents.
d. Attach shipping label (DD Form 1387) to the outside of the shipping carton.

CHAPTER 7

PARTS LIST

7-1. General. This chapter contains an illustrated parts list for the test set. Part numbers used in the parts list are Government Standard, UMC Electronics, or vendor part numbers. When a vendor part number is used, the vendor is identified by a five-digit code in parentheses in the Part Name column; the UMC Electronics part number for that part is also included in the Part Name column. If no vendor code is included in the Part Name column, the part number is a Government standard part number or a UMC Electronics part number.

7-2. Vendor Codes. Codes used to identify vendors are those specified in Cataloging Handbook H4-1. Vendor codes used in this parts list and the corresponding manufacturer's names and addresses are listed below.

CODE	MANUFACTURER'S NAME AND ADDRESS
04713	Motorola Semiconductor Products Inc. Phoenix, Arizona 85008
05820	Wakefield Engineering Inc. Wakefield, Massachusetts 01880
06090	Raychem Corporation Redwood City, California 94063
09922	Burndy Corporation Norwalk, Connecticut 06852
12697	Clarostat Manufacturing Co., Inc. Dover, New Hampshire 03820
15235	Crouse-Hinds Co. Syracuse, New York 13201
15605	Cutler Hammer Inc. Milwaukee, Wisconsin 53216
22680	UMC electronics Co. North Haven, Conn. 06473
22840	Electronic Precision Components Providence, Rhode Island
23050	Products Components Corp. Mount Vernon, New York 10553
23223	CTS Microelectronics Inc. West Lafayette, Indiana 47902
25795	W.W. Grainger, Inc. Chicago, Illinois 60648
33910	Greene Rubber Co. Inc. North Haven, Conn. 06473
44655	Ohmite Manufacturing Co. Skokie, Illinois 60076

CODE	MANUFACTURER'S NAME AND ADDRESS
51506	Accurate Screw Machine Co. Nutley, New Jersey 07110
55566	R.A.F. Electronic Hardware 260 Hathaway Dr., Stratford, Conn, 06497
59730	Thomas and Betts Co. Elizabeth, New Jersey 07207
71279	Cambion Cambridge Thermionic Corp. Cambridge, Massachusetts 02138
71785	Cinch Manufacturing Co. Howard B. Jones Division Chicago, Illinois
72512	Harry B. Davies Molding Co. Chicago, Illinois 60639
73559	Carling Electric Inc. West Hartford, Connecticut 06107
75042	IRC Inc. Division of TRW Electronic Components Philadelphia, Pennsylvania 19108
76545	Mueller Electric Co. Cleveland, Ohio 44114
77342	American Machine and Foundry Co. Potter and Brumfield Division Princeton, Indiana 47570
80188	U.S. Machine Corp. Lebanon, Indiana
83330	H.H. Smith Inc. Brooklyn, New York 11207
92194	Alpha Wire Corp. Elizabeth, New Jersey 07207
98003	Nielsen Hardware Corp. Hartford, Connecticut

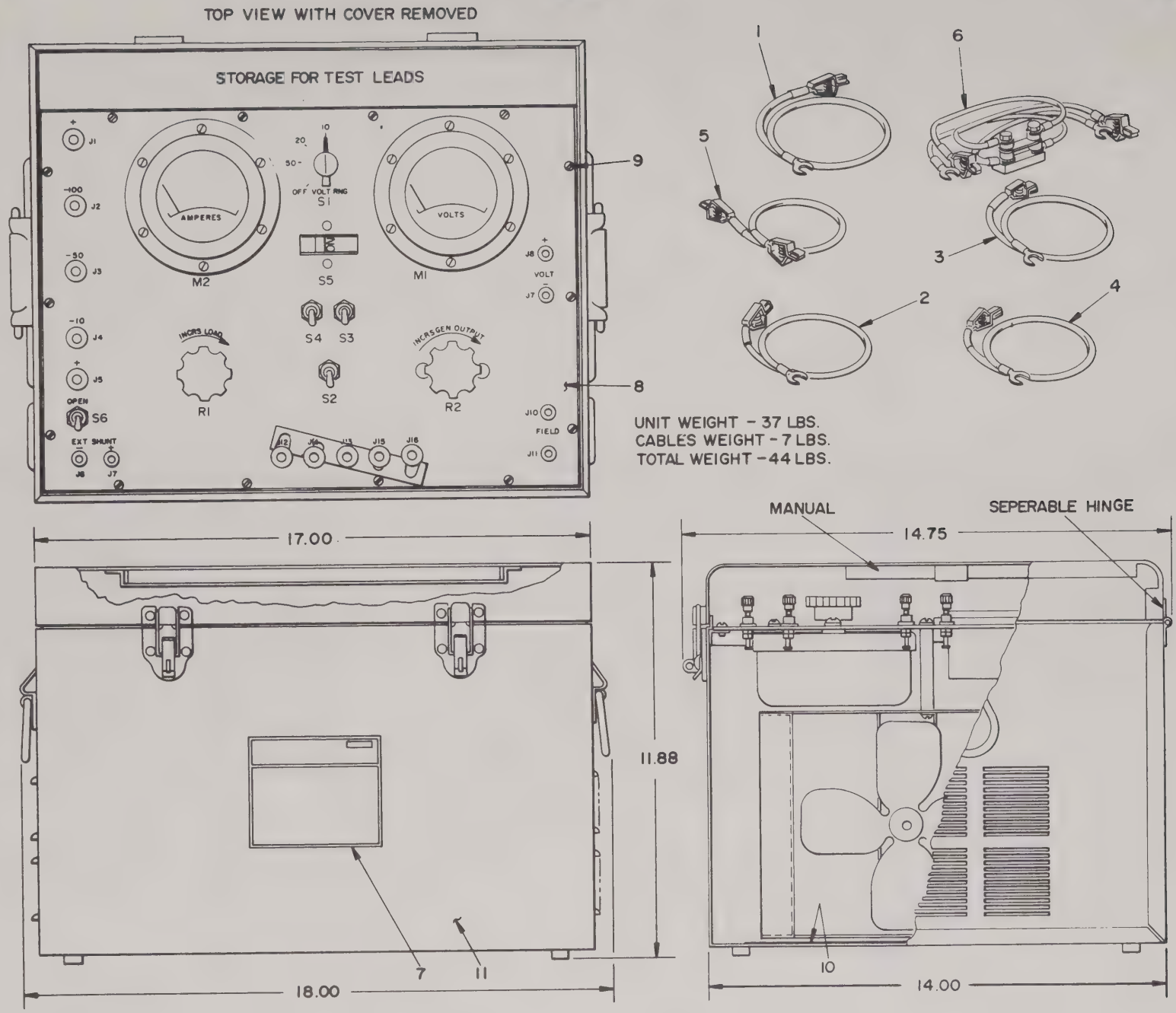


Figure 7-1. Low voltage test set.

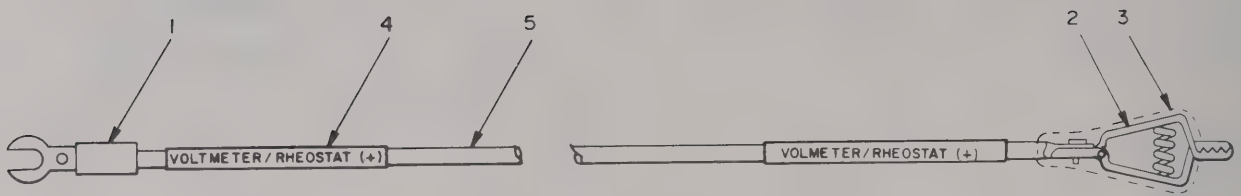


Figure 7-2. Positive voltmeter/rheostat cable assembly

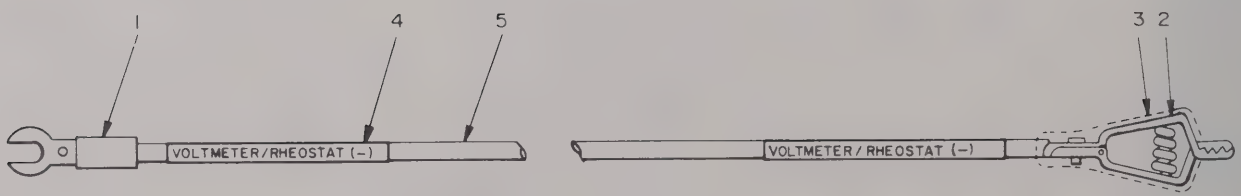


Figure 7-3. Negative voltmeter/rheostat cable assembly

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-1-	7541	TEST SET, LOW VOLTAGE CIRCUIT, AUTOMOTIVE TYPE, 12/24V DC, MODEL LVTS	
-1	48981	CABLE ASSY, Voltmeter/rheostat, positive (fig. 7-2)	2
-2	48982	CABLE ASSY, Voltmeter/rheostat, negative (fig. 7-3)	2
-3	48983	CABLE ASSY, Ammeter, positive (fig. 7-4)	1
-4	48984	CABLE ASSY, Ammeter, negative (fig. 7-5)	1
-5	48985	CABLE ASSY, Jumper (fig. 7-6)	1
-6	48986	SHUNT ASSY, External, 500 ampere (fig. 7-7)	1
-7	422019	NAMEPLATE, Low voltage test set	1
-8	58015	UNIT SUBASSEMBLY (fig. 7-8)	1
-9	40591	SCREW, Pan head, self-tapping, no. 8, 3/8 in. long, type B, cadmium plated, per QQ-P-416, type II, class B	14
-10	33071	SCHEMATIC, Reduced, paper in plastic laminate, pressure sensitive adhesive back	1
-11	58011	CASE ASSY (fig. 7-9)	1

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-2-	48981	CABLE ASSY, VOLTMETER/RHEOSTAT, POSITIVE	Ref.
-1	400	LUG, Spade, insulated red (83330) (UMC PN 91845)	1
-2	48-C	CLIP, Electrical, type PC, item 2 per W-C-440 (76545) (UMC PN 391236)	1
-3	49	INSULATOR, Red, for type PC, item 2 clip per W-C-440 (76545) (UMC PN 51697)	1
-4	301997-1	MARKER, Tubing, voltmeter/rheostat (+)	2
-5	62832	WIRE, Size 16 single conductor, MIL-C-13846, type I, class A, 9 feet long	1

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-3-	48982	CABLE ASSY, VOLTMETER/RHEOSTAT, NEGATIVE	Ref.
-1	400	LUG, Spade, insulated, black (83330) (UMC PN 91846)	1
-2	48-C	CLIP, Electrical, type PC, item 2 clip per W-C-440 (76545) (UMC PN 391236)	1
-3	49	INSULATOR, Black, for type PC, item 2 per W-C-440 (76545) (UMC PN 51698)	1
-4	301997-2	MARKER, Tubing, voltmeter/rheostat (–)	2
-5	62831	WIRE, Size 16 single conductor, MIL-C-13846, type I, class A, 9 feet long	1

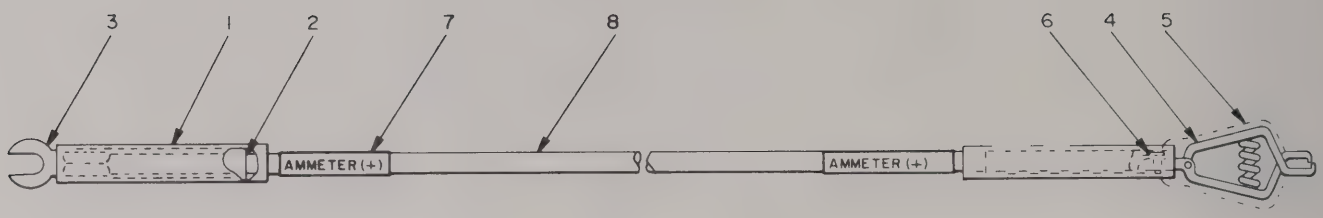


Figure 7-4. Positive ammeter cable assembly

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-4-	48983	CABLE ASSY, AMMETER, POSITIVE	Ref.
-1	RNF-100	TUBING, Heat shrinkable, red, 3/4 in. diameter, 2.5 in. long (06090) (UMC PN 202652)	2
-2	SCL	TUBING, Heat shrinkable, 3/4 in. diameter, 2 in. long (06090) (UMC PN 202651)	2
-3	91848	LUG, Ring tongue, uninsulated, no. 6 wire, 1/4 in. diameter stud	1
-4	21-C	CLIP, Electrical, type PCL, item 1 per W-C-440 (76545) (UMC PN 391237)	1
-5	23	INSULATOR, Red, for type PCL, item 1 clip per W-C-440 (76545) (UMC PN 51699)	1
-6	E26	TERMINAL, Ring, uninsulated, AWG-6 wire, 10 stud size (59730) (UMC PN 202675)	1
-7	301997-3	MARKER, Tubing, ammeter (+)	2
-8	62833	WIRE, Size 6 single conductor, MIL-C-13486, type I, class A, 9 feet long	1

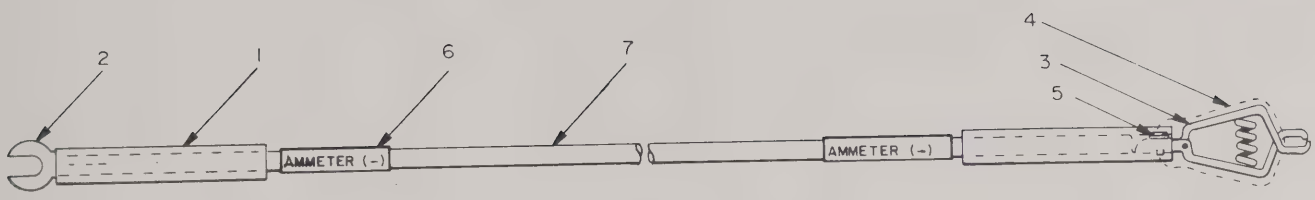


Figure 7-5. Negative ammeter cable assembly

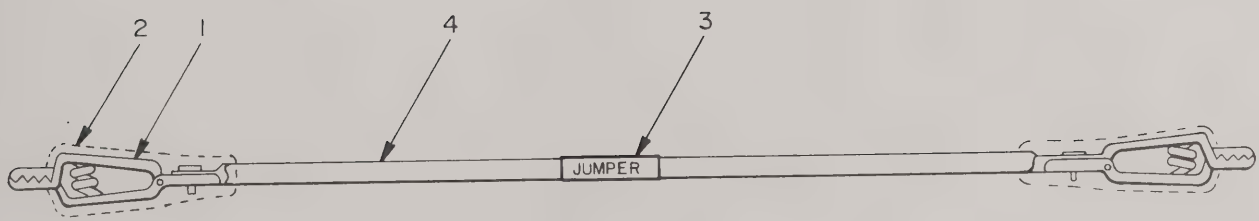


Figure 7-6. Jumper cable assembly

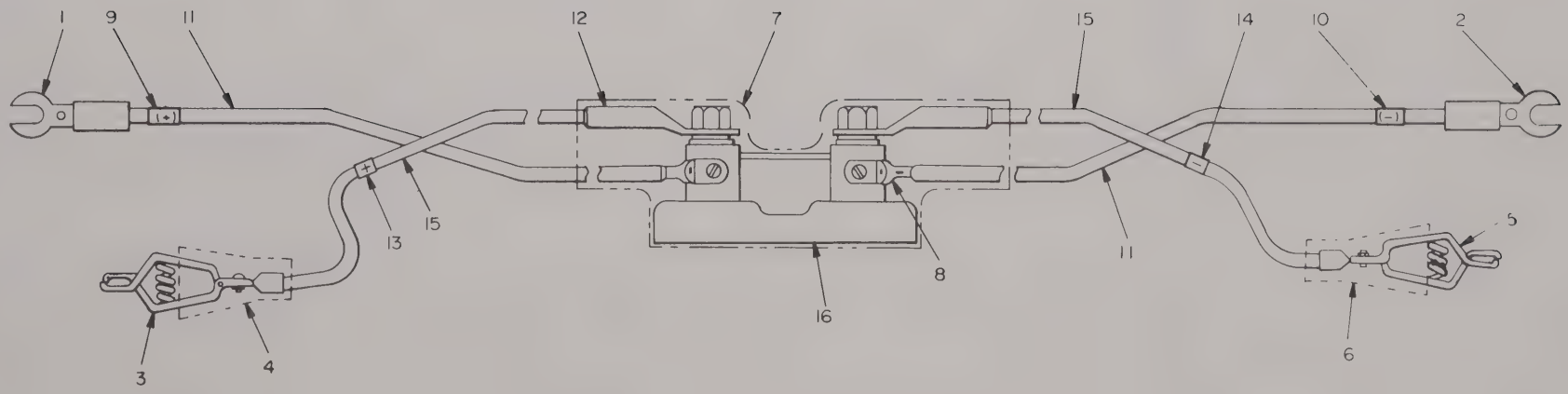


Figure 7-7. 500 ampere external shunt assembly

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-5-	48984	CABLE ASSY, AMMETER, NEGATIVE	Ref.
-1	SCL	TUBING, Heat shrinkable, 3/4 in. diameter, 2.5 in. long (06090) (UMC PN 202651)	2
-2	91848	LUG, Ring tongue, uninsulated, no. 6 wire, 1/4 in. diameter stud	1
-3	21-C	CLIP, Electrical, type PCL, item 1 per W-C-440 (76545) (UMC PN 391237)	1
-4	23	INSULATOR, Black, for type PCL, item 1 clip per W-C-440 (76545) (UMC PN 61600)	1
-5	E26	TERMINAL, Ring, uninsulated, AWG-6 wire, 10 stud size (59730) (UMC PN 202675)	1
-6	301997-4	MARKER, Tubing, ammeter (–)	2
-7	62833	WIRE, Size 6 single conductor, MIL-C-13486, type I, class A, 9 feet long	1

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-6-	48985	CABLE ASSY, JUMPER	Ref.
-1	45-C	CLIP, Electrical, type PC, item 1 per W-C-440 (76545) (UMC PN 391238)	2
-2	47	INSULATOR, Black, for type PC, item 1 clip per W-C-440 (76545) (UMC PN 61601)	2
-3	301997-5	MARKER, Tubing, jumper	1
-4	62832	WIRE, Size 16 single conductor, MIL-C-13486, type I, class A, 1 foot long	1

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-7-	48986	SHUNT ASSY, EXTERNAL, 500 AMPERE	Ref.
-1	400	LUG, Spade, insulated, red (83330) (UMC PN 91845)	1
-2	400	LUG, Spade, insulated, black (83330) (UMC PN 91846)	1
-3	11-C	CLIP, Electrical, copper, 200 ampere, type PCL-2 per W-C-440B, marked + (76545) (UMC PN 391268)	1
-4	13	INSULATOR, Red (76545) (UMC PN 391270)	1
-5	11-C	CLIP, Electrical, copper, 200 ampere, type PCL-2 per W-C-440B, not marked (76545) (UMC PN 391269)	1
-6	13	INSULATOR, Black (76545) (UMC PN 391271)	1
-7	FIT-221-1-1/2	TUBING, Shrinkable, black, 1-1/2 in. diameter, 7-1/2 in. long (92194) (UMC PN 202677)	1
-8	YAV14-T1	TERMINAL, Ring tongue, for no. 16 wire and no. 6 screw (09922) (UMC PN 202649)	2
-9	301997-6	MARKER, Tubing (+)	1
-10	301997-7	MARKER, Tubing (–)	1
-11	62832	WIRE, Size 16 single conductor, MIL-C-13486, type I, class A, 9 feet long	2
-12	YAV25-L	TERMINAL, Ring tongue, for no. 0 wire and 3/8 in. stud (09922) (UMC PN 202648)	2
-13	301997-8	MARKER, Tubing, (+)	1
-14	301997-9	MARKER, Tubing, (–)	1
-15	331289	CABLE, Welding, flexible, standard AWG-1/0 single conductor, black neoprene insulation, 300 volt, 1 foot long	2
-16	MVB500A/ 50mV	SHUNT, 500 amperes DC, 50 millivolt ±0.25%, 25 watt (22840) (UMC PN 112425)	1

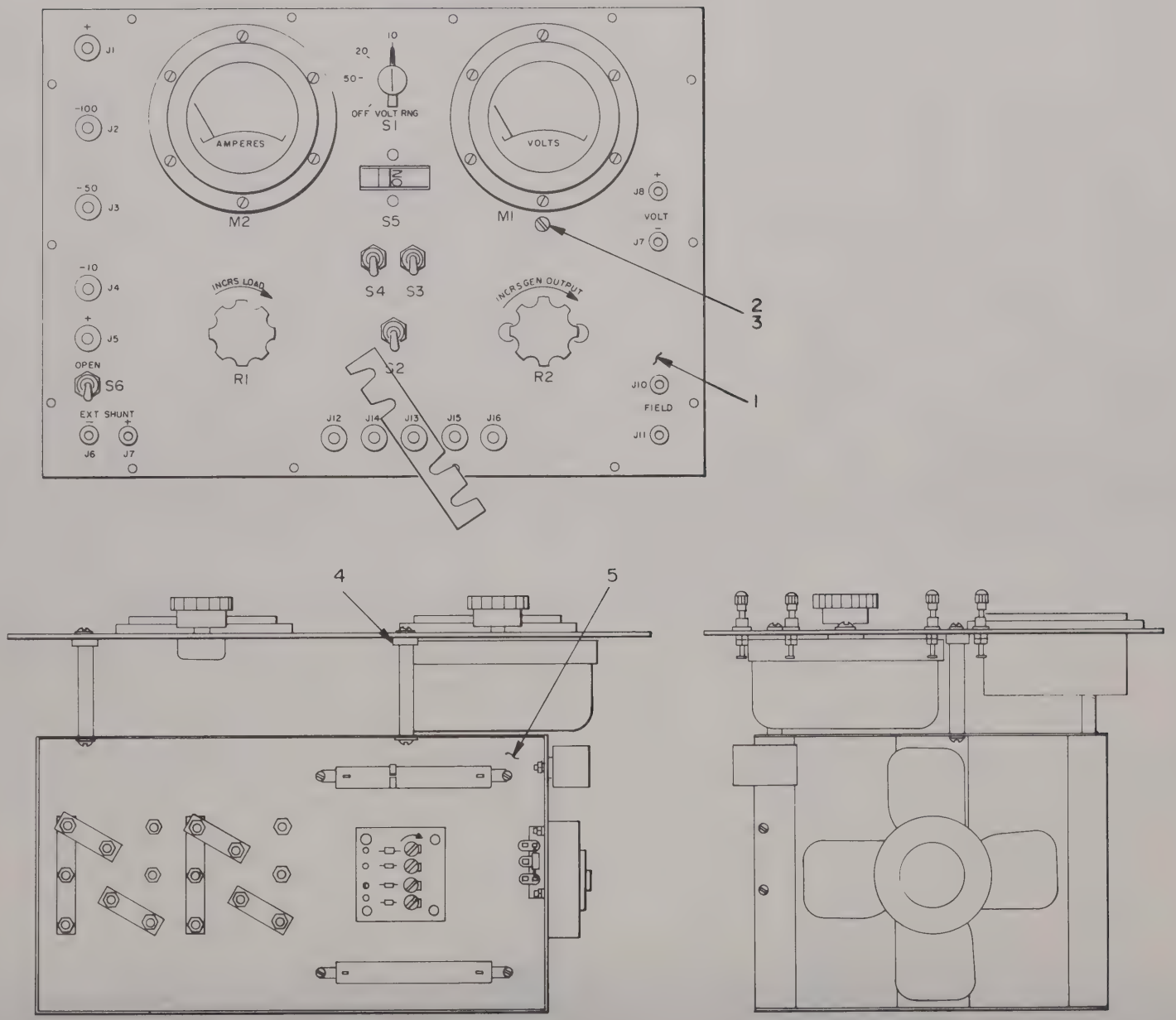


Figure 7-8. Unit subassembly

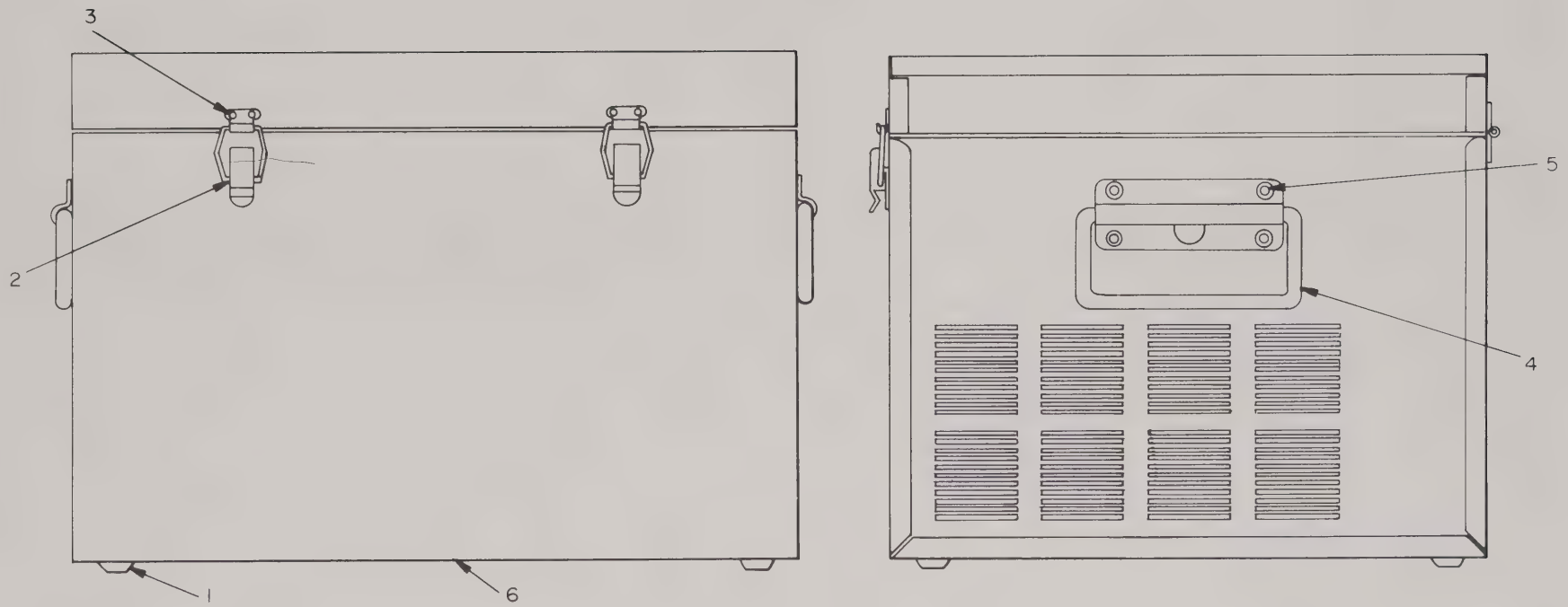
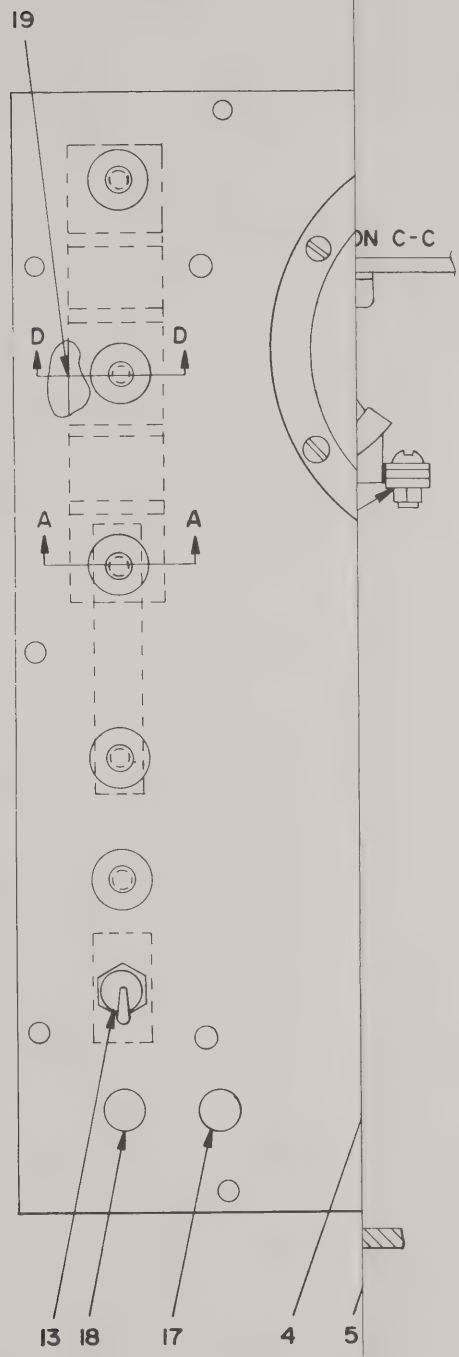


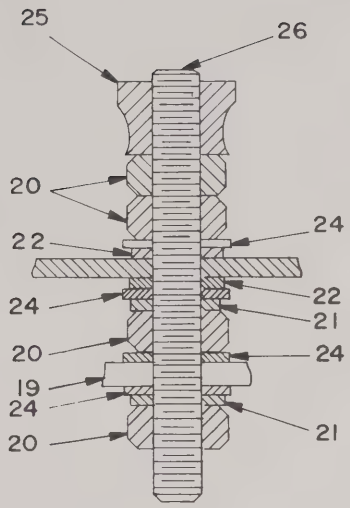
Figure 7-9. Case assembly

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-8-	58015	UNIT SUBASSEMBLY	Ref.
-1	489992	CONTROL PANEL ASSY (fig. 7-10)	1
-2	70585	SCREW, Machine, pan head, 10-32 by 5/8 in. long, steel, cadmium plated, QQ-P-416, type II, class B	5
-3	30202	WASHER, Lock, no. 10, steel, shake-proof, external tooth, QQ-P-416, type II, class B	5
-4	1154-10-A-O	SPACER, for no. 10-32 screw, .187 thick, (55566) (UMC PN 112454)	5
-5	48991	LOAD BANK ASSEMBLY (fig. 7-11)	1

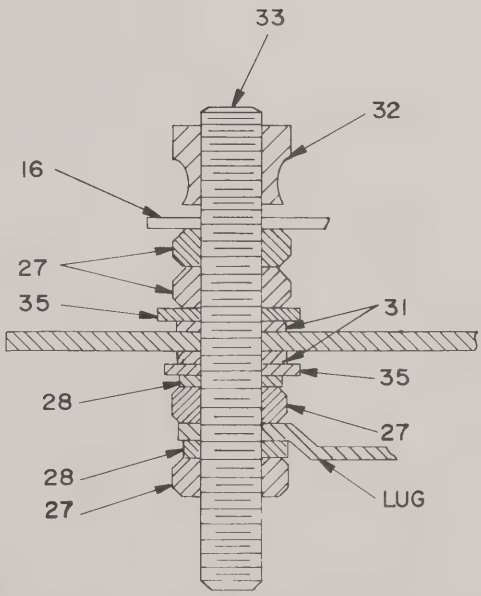
FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-9-	58011	CASE ASSY	Ref.
-1	5023	BUMPER, Self-stick, grey (23050) (UMC PN 411129)	4
-2	HC-200-ZE	CLASP, Pull down (98003) (UMC PN 331238)	2
-3	AD42ABS	RIVET, Pop, open end, 1/8 in. diameter, 1/8 in. maximum grip length, dome head, aluminum (80188) (UMC PN 272292)	8
-4	H595-LS-ZE	HANDLE (98003) (UMC PN 101565)	2
-5	AD62ABS	RIVET, Pop, open end, 3/16 in. diameter, 1/8 in. maximum grip length, dome head, aluminum (80188) (UMC PN 20297)	8
-6	391253	CASE, Low voltage tester	1

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-10-	48992	CONTROL PANEL ASSY	Ref.
-1	81073	AMMETER, –15/0/50 mV DC, 4-1/2 in. round, ruggedized (22680)	1
-2	192775	VOLTMETER, 0-1 mA DC, 4-1/2 in. round, ruggedized (22680)	1
-3	800-5	SWITCH, Rotary, 5 position, 45° indexing, non-shortening, 15/32 in. diameter flatted bushing with mounting hardware and knob (73559) (UMC PN 142512)	1
-4	4102	KNOB, For 1/4 in. diameter shaft, with setscrew (72512) (UMC PN 41776)	1
-5	SERIES 380	POTENTIOMETER, 10k ±10%, linear taper, 3/4 in. long shaft (12697) (UMC PN 1002168)	1
-6	4102	KNOB, For 3/8 in. diameter shaft, with setscrew (72512) (UMC PN 41774)	1
-7	272264	RHEOSTAT, 5 in. diameter, taper wound, 15 amperes maximum, 70 ohms maximum	1
-8	20382	SCREW, Machine, round head, 1/4-20 by 1/2 in. long, steel, UNC-2A, cadmium plated, QQ-P-416, type II, class B	2
-9	30203	WASHER, Lock, 1/4 in., steel, shake-proof, external tooth, cadmium plated, QQ-P-416, type II, class B	2
-10	109764	BUS BAR, Load bank switch (22680)	2
-11	7828B	SWITCH, Toggle, 2PST, 60 amperes at 250 volts (15235) (UMC PN 142516)	1
-12	10594	SCREW, Binding head, 6-32 by 3/8 in. long, steel, cadmium plated, QQ-P-416, type II, class B	2
-13	7500K14	SWITCH, Toggle, 1PST (15605) (UMC PN 142515)	2
-14	7576K2	SWITCH, Toggle, 1PST, 2 pole base (15605) (UMC PN 42514)	1
-15	7599K1	SWITCH, Toggle, 2PST (15605) (UMC PN 42513)	1
-16	109693	LINK (22680)	1
-17	378RED	BINDING POST, 15 ampere, for steel panel, red (83330) (UMC PN 811117)	2
-18	378BLACK	BINDING POST, 15 ampere, for steel panel, black (83330) (UMC PN 811118)	4
-19	109689	SHUNT	1
-20	10031	NUT, Hex, 1/4-20, brass, UNC-2B, regular	15
-21	10215	WASHER, Lock, 1/4 in., bronze, SAE medium, plain	10
-22	2154	WASHER, Shoulder, fiber, for 1/4 in. screw (83330) (UMC PN 10681)	10
-23	1N4004	DIODE, 1A 400 P1V, (UMC PN 51326)	1
-24	40608	WASHER, Flat, brass, for 1/4 in. screw, 0.260 in. ID, 9/16 in. OD, 0.065 in. thick	20
-25	1317	NUT, Thumb, knurled, 1/4-20, brass (83330) (UMC PN 30087)	5
-26	109762	STUD, Brass, 1/4-20 by 2-1/4 in. long (22680)	5
-27	30088	NUT, Hex, 5/16-18, brass, UNC-2B, regular	15
-28	20217	WASHER, Lock, 5/16, SAE medium, bronze	10
-29	109690	SHUNT	1
-31	1559A-.050-.040-F	WASHER, Shoulder, fiber, for 5/16 in. screw (17036) (UMC PN 10683)	10
-32	67314-B-1	NUT, Thumb, knurled, 5/16-18, brass (10684) (UMC PN 30089)	5
-33	109763	STUD, Brass, 5/16-18 by 2-1/2 in. long (22680)	5
-34	109691	PANEL, Control (22680)	1
-35	40613	WASHER, Flat, brass, for 5/16 screw, .336 ID x .75 OD x .064 thick	10



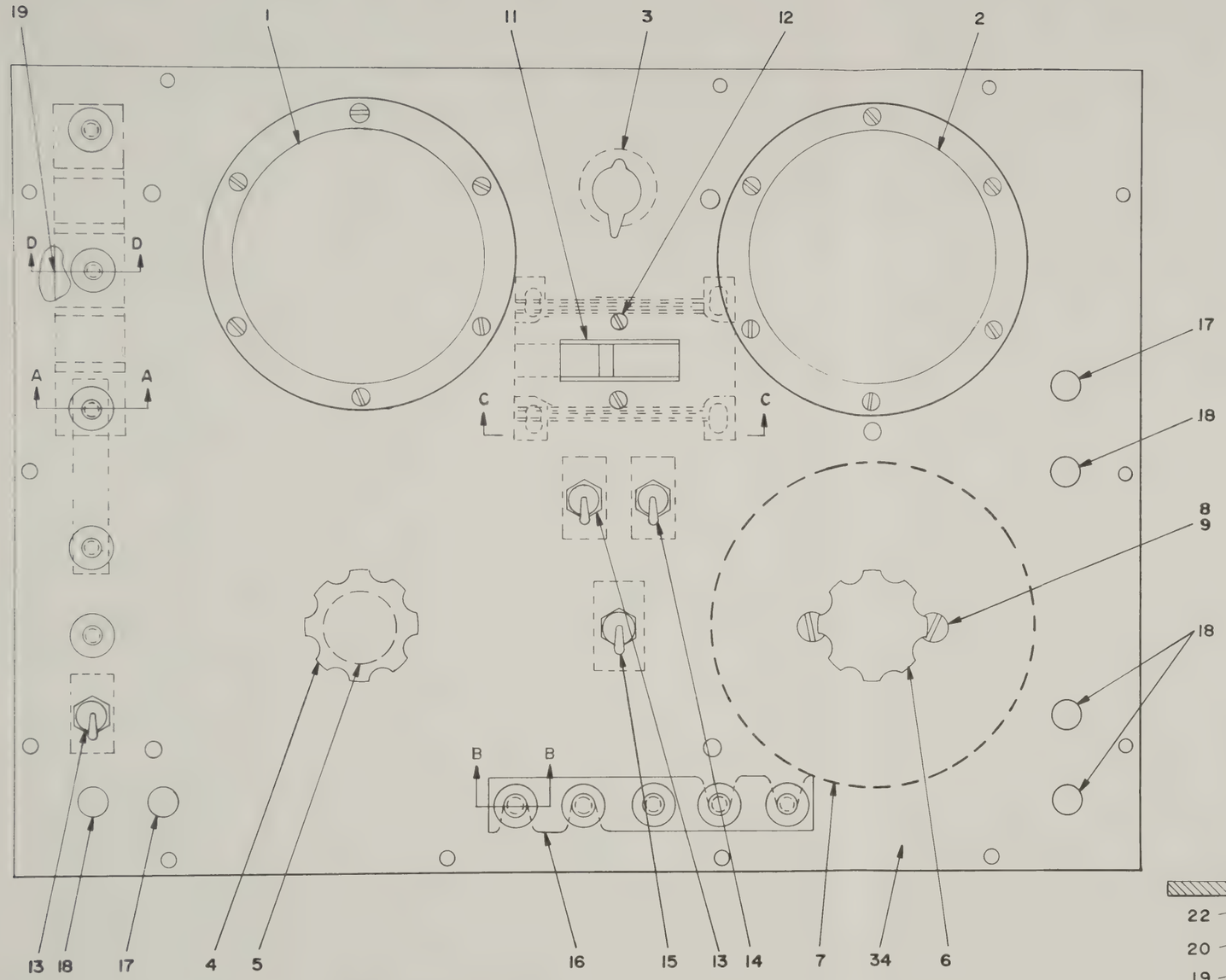


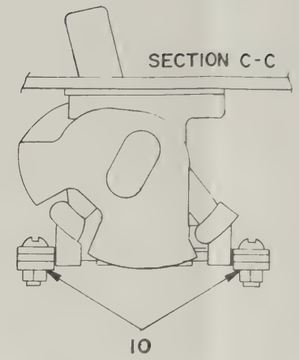
SECTION D-D
BINDING POST

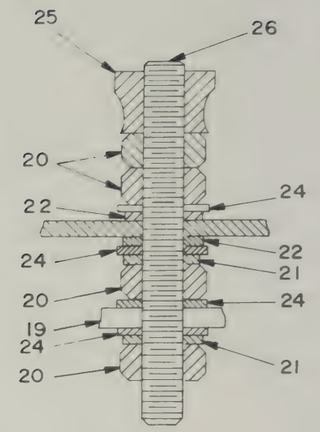


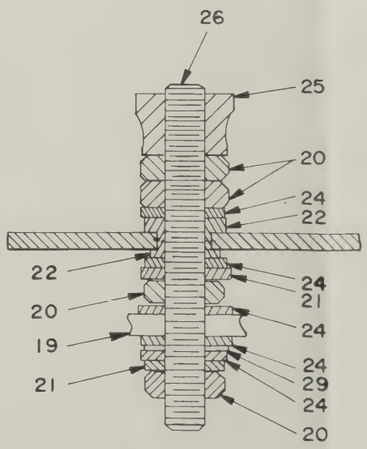
SECTION B-B
LINK POST

Control panel assembly









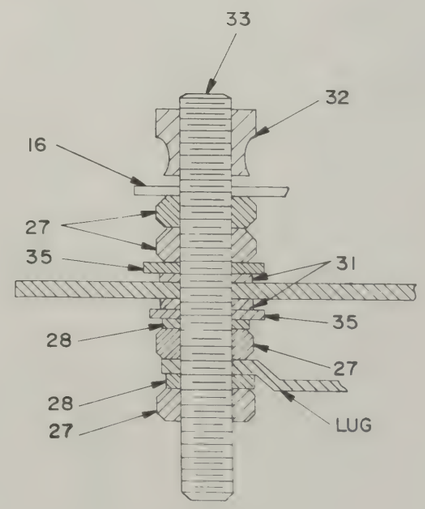
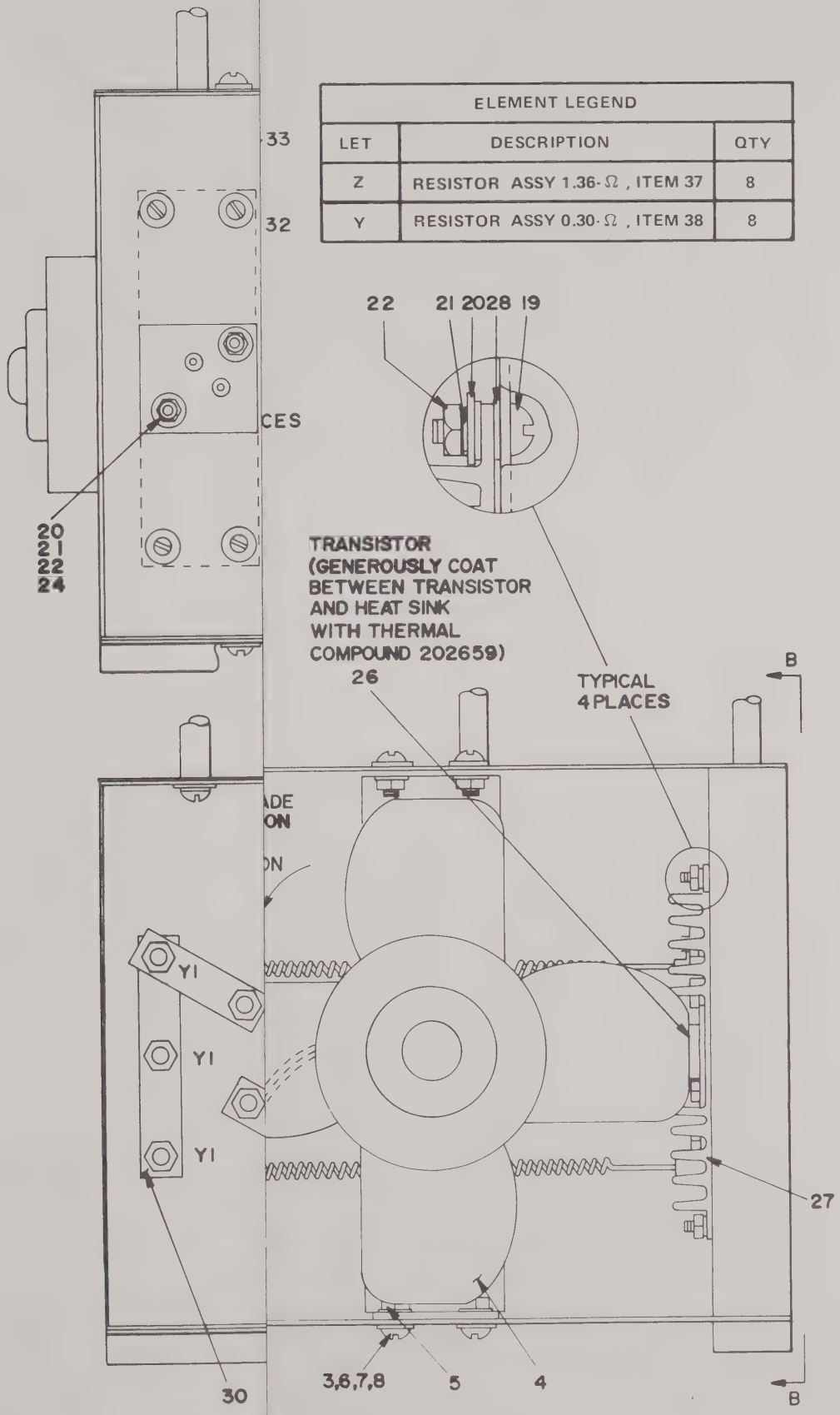
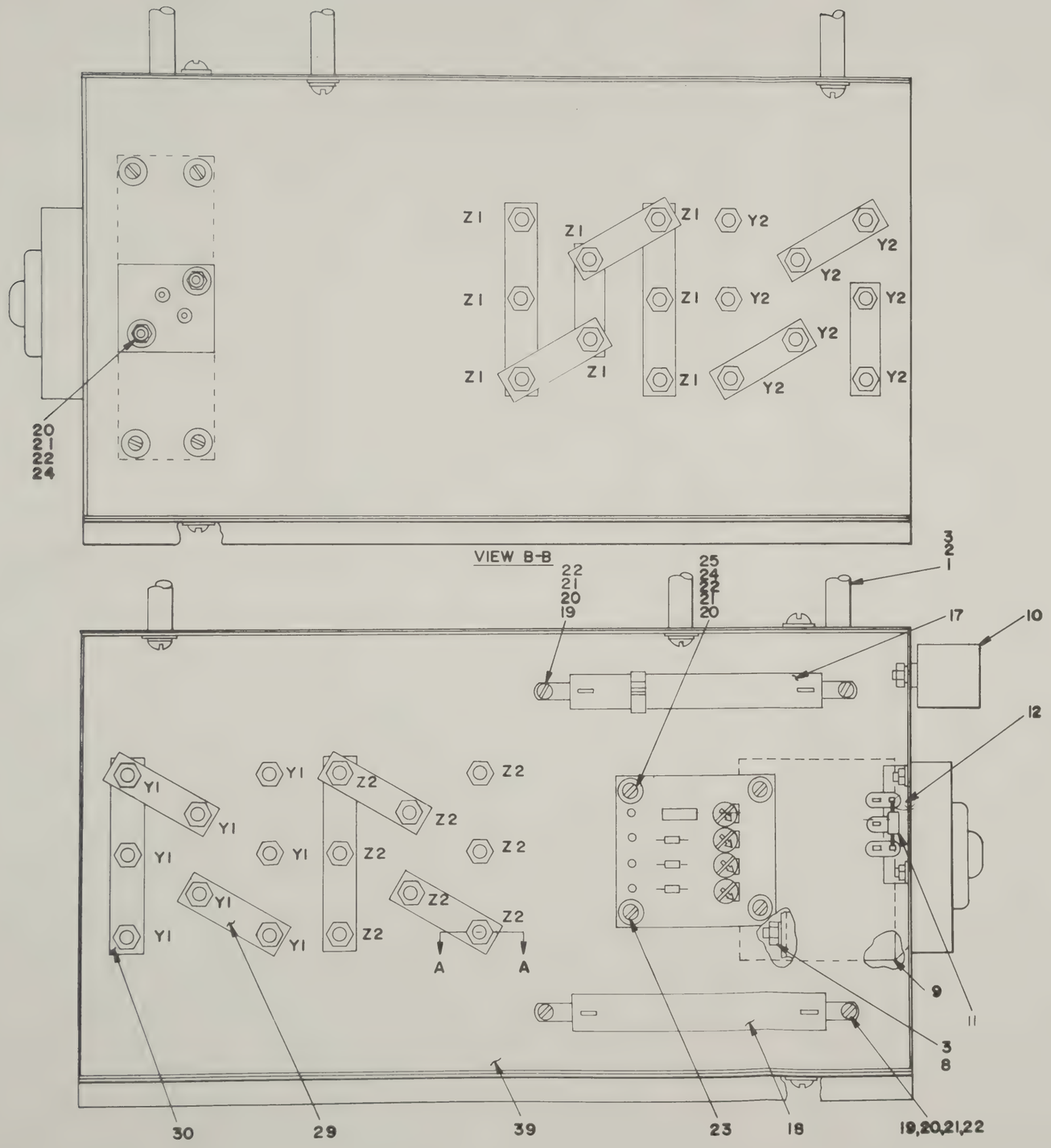
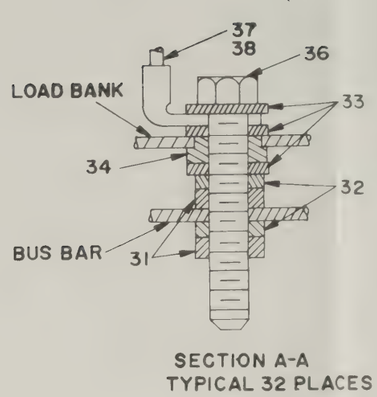


Figure 7-10. Control panel assembly



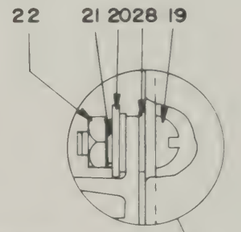
. Load bank assembly





SECTION A-A
TYPICAL 32 PLACES

ELEMENT LEGEND		
LET	DESCRIPTION	QTY
Z	RESISTOR ASSY 1.36-Ω , ITEM 37	8
Y	RESISTOR ASSY 0.30-Ω , ITEM 38	8



TRANSISTOR
(GENEROUSLY COAT
BETWEEN TRANSISTOR
AND HEAT SINK
WITH THERMAL
COMPOUND 202659)

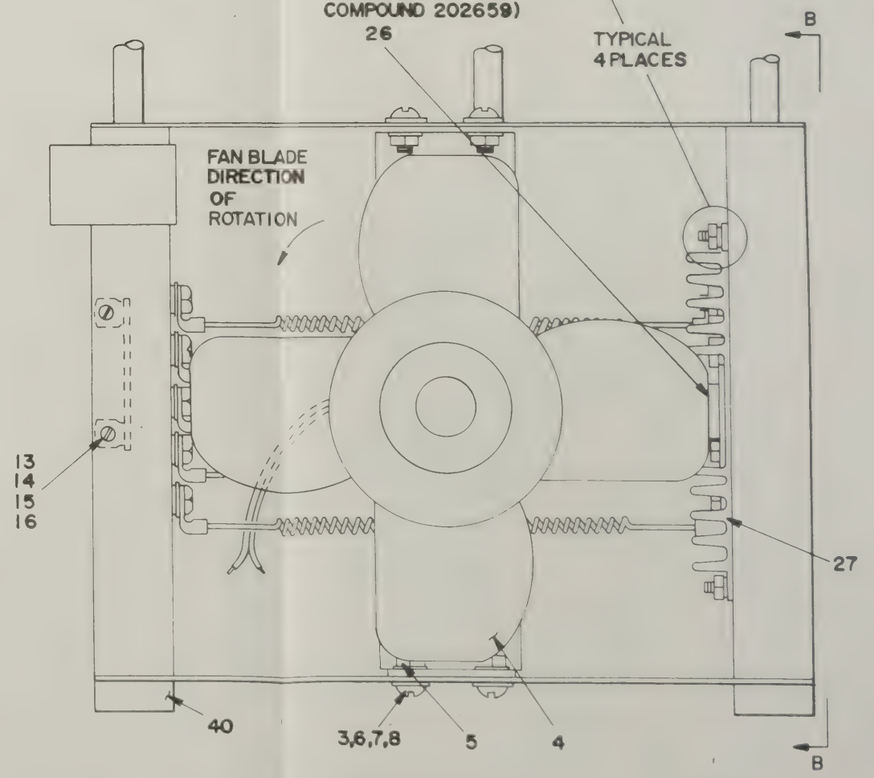


Figure 7-11. Load bank assembly

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-11-	48991	LOAD BANK ASSY	Ref.
-1	1350-R-S	SPACER, Threaded, 3/8 in. OD, 2.50 in. long, 10-32 thread both ends (51506) (UMC PN 112427)	5
-2	10371	SCREW, Machine, round head, 10-32 by 5/8 in. long, steel, UNF-2A, cadmium plated, QQ-P-416, type II, class B	5
-3	30202	WASHER, Lock, no. 10, steel, shake-proof, external tooth, cadmium plated, QQ-P-416, type II, class B	11
-4	4C472	BLADE, 6-1/2 in. diameter (25795) (UMC PN 811122)	1
-5	109696	BRACKET, Motor (22680)	1
-6	10350	SCREW, Machine, round head, 10-32 by 5/16 in. long, steel, UNF-2A, cadmium plated, QQ-P-416, type II, class B	4
-7	30606	WASHER, Plain, no. 10, steel, SAE medium, cadmium plated, QQ-P-416, type II, class B	4
-8	10085	NUT, Hex, 10-32, steel, UNF-2B, cadmium plated, QQ-P-416, type II, class B	6
-9	2M197	MOTOR, 12V DC, 1/35 hp, 2350 rpm (25795) (UMC PN 301990)	1
-10	KA5DY	RELAY, 24V DC, SPDT (77342) (UMC PN 272294)	1
-11	2883	RESISTOR, 360 ohms, 5-1/4 watt (44655) (UMC PN 272295)	1
-12	53	BLOCK, Terminal, 3 pole, lug type (71785) (UMC PN 21146)	1
-13	30365	SCREW, Machine, round head, 4-40 by 1/4 in. long, steel, UNC-2A, cadmium plated, QQ-P-416, type II, class B	2
-14	10638	WASHER, Plain, no. 4, steel, SAE medium, cadmium plated, QQ-P-416, type II, class B	2
-15	30200	WASHER, Lock, no. 4, steel, shake-proof, external tooth, cadmium plated, QQ-P-416, type II, class B	2
-16	10030	NUT, Hex, 4-40, steel, UNC-2B, cadmium plated, QQ-P-416, type II, class B	2
-17	0560D	RESISTOR, Adjustable, 4 ohms ±10%, 50 watts, with standard plated steel mounting brackets (44655) (UMC PN 272272)	1
-18	0400N	RESISTOR, Fixed, 4 ohms ±10%, 50 watts, with standard plated steel mounting brackets (44655) (UMC PN 272273)	1
-19	10354	SCREW, Machine, round head, 6-32 by 1/2 in. long, steel, UNC-2A, cadmium plated, QQ-P-416, type II, class B	8
-20	10637	WASHER, Plain, no. 6, steel, SAE medium, cadmium plated, QQ-P-416, type II, class B	14
-21	30201	WASHER, Lock, no. 6, steel, shake-proof, external tooth, cadmium plated, QQ-P-416, type II, class B	15
-22	10083	NUT, Hex, 6-32, steel, UNC-2B, cadmium plated, QQ-P-416, type II, class B	15
-23	58014	P.C. BOARD ASSY, Meter calibrating (fig. 7-12)	1
-24	10356	SCREW, Machine, round head, 6-32 by 5/8 in. long, steel, UNC-2A, cadmium plated, QQ-P-416, type II, class B	6
-25	2100	SPACER, Brass, zinc plated, 0.250 in. OD, 0.140 in. ID, 0.250 in. long (83330) (UMC PN 112437)	4
-26	MJ11032 (NPN)	TRANSISTOR, Darlington, T03 case (04713) (UMC PN 202658)	1
-27	621-A	HEAT SINK, T03 transistor (05820) (UMC PN 101560)	1
-28	103	INSULATOR, For 600 series heat sinks (05820) (UMC PN 61605)	4
-29	109694	BUS BAR, Load bank (22680)	10
-30	109695	BUS BAR, Load bank (22680)	4
-31	10068	NUT, Hex, 10-24, brass, NC-2B, regular	64
-32	20204	WASHER, Lock, no. 10, bronze, SAE heavy	64

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-11-33	20614	WASHER, Flat, brass, no. 10 7/16 in., OD, 0.20 in. ID, 0.036 in. thick	96
-34	2156	WASHER, Shoulder, fiber, for no. 10 screw (83330) (UMC PN 10664)	32
-35	2164	WASHER, Flat, fiber, for no. 10 screw, 0.196 in. ID, 0.375 in. OD, 1/16 in. thick (83330) (UMC PN 10680)	32
-36	50506	SCREW, Machine, hex head, 10-24 by 1 in. long, brass, UNC-2A	32
-37	58027	RESISTOR ASSY, 1.36 ohms (fig. 7-13)	8
-38	58026	RESISTOR ASSY, 0.90 ohm (fig. 7-14)	8
-39	109692	ENCLOSURE, Load bank (22680)	1
-40	2218-WA	FOAM RUBBER STRIP, 3/8" thick x 1 in. wide x 13 in. long (33910) (UMC PN 721425)	2

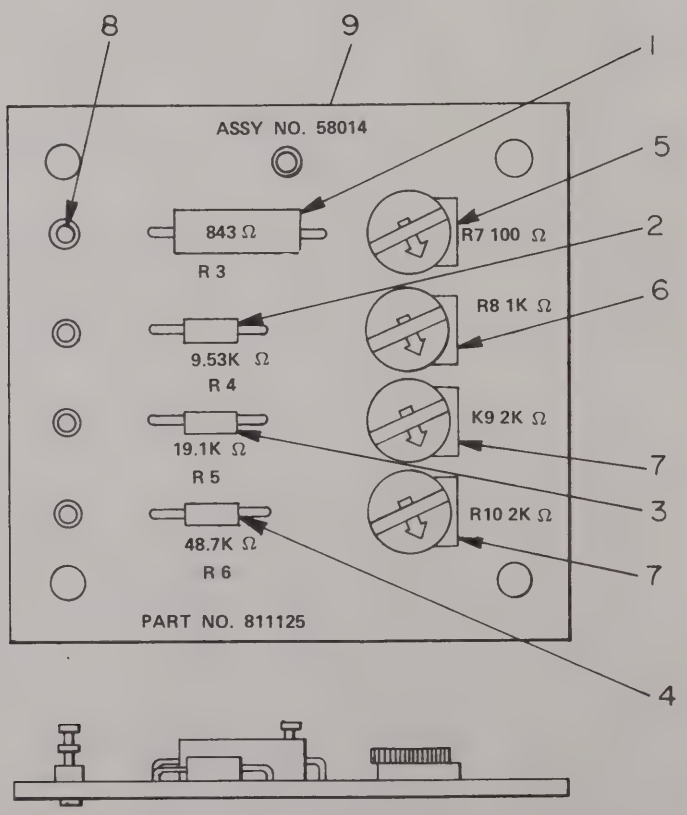


Figure 7-12. Meter calibrating p.c. board assembly

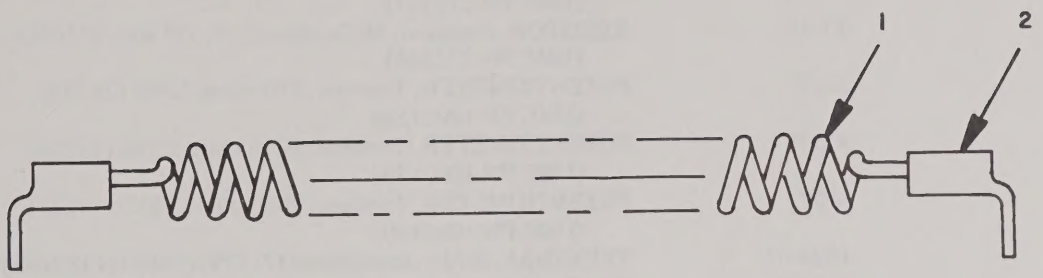


Figure 7-13. Resistor assembly, 1.36 ohms

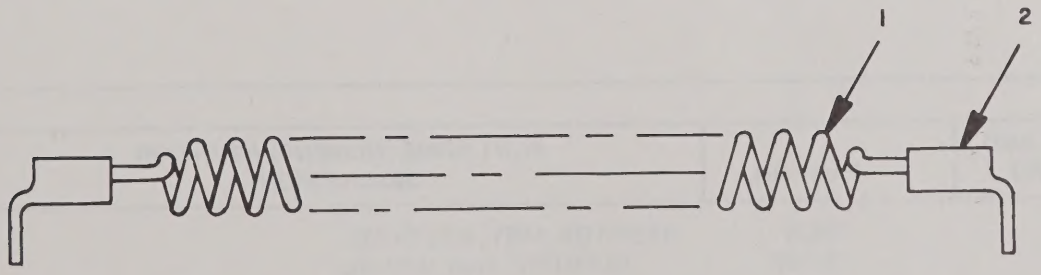


Figure 7-14. Resistor assembly, 0.90 ohms

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-12-	58014	METER CALIBRATING P.C. BOARD ASSY	Ref.
-1	T2-65	RESISTOR, Precision, 845 ohms ±1%, 1/ watt (75042) (UMC PN 272265)	1
-2	T2-55	RESISTOR, Precision, 9.53k ohms ±1%, 1/4 watt (75042) (UMC PN 272266)	1
-3	T2-55	RESISTOR, Precision, 19.1k ohms ±1%, 1/4 watt (75042) (UMC PN 272267)	1
-4	T2-55	RESISTOR, Precision, 48.7k ohms ±1%, 1/4 watt (75042) (UMC PN 272268)	1
-5	375T	POTENTIOMETER, Trimmer, 100 ohms ±20% (23223) (UMC PN 1002158)	1
-6	375T	POTENTIOMETER, Trimmer, 1000 ohms ±20% (23223) (UMC PN 1002159)	1
-7	375T	POTENTIOMETER, Trimmer, 2000 ohms ±20% (23223) (UMC PN 1002160)	2
-8	1026-02	TERMINAL, Solder, uninsulated (71279) (UMC PN 182691)	5
-9	811125	BOARD, Printed circuit	1

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-13-	58027	RESISTOR ASSY, 1.36 OHMS	Ref.
-1	121384	ELEMENT, Load, 1.36 ohms	1
-2	C26	TERMINAL, Non-insulated, ring type, 12-10 wire size, stud size 10 (59730) (UMC PN 202680)	2

FIGURE AND INDEX NO.	PART NO.	PART NAME (NOMENCLATURE OR DESCRIPTION)	QTY.
7-14-	58026	RESISTOR ASSY, 0.90 OHMS	Ref.
-1	121385	ELEMENT, Load, 0.90 ohms	1
-2	C26	TERMINAL, Non-insulated, ring type, 12-10 wire size, stud size 10 (59730) (UMC PN 202680)	2